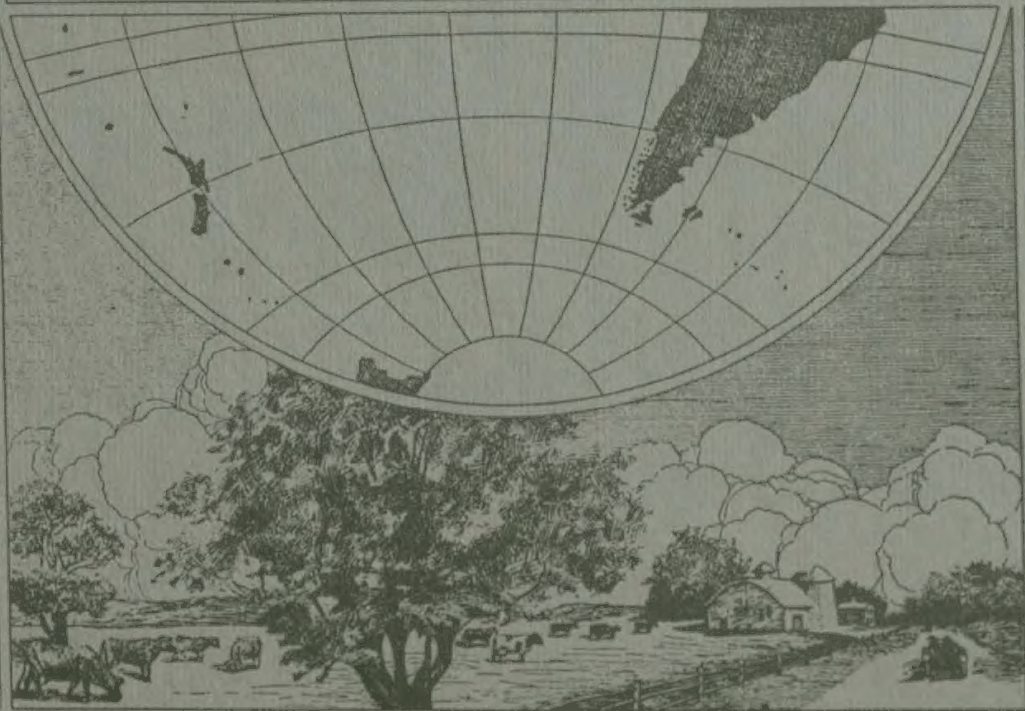
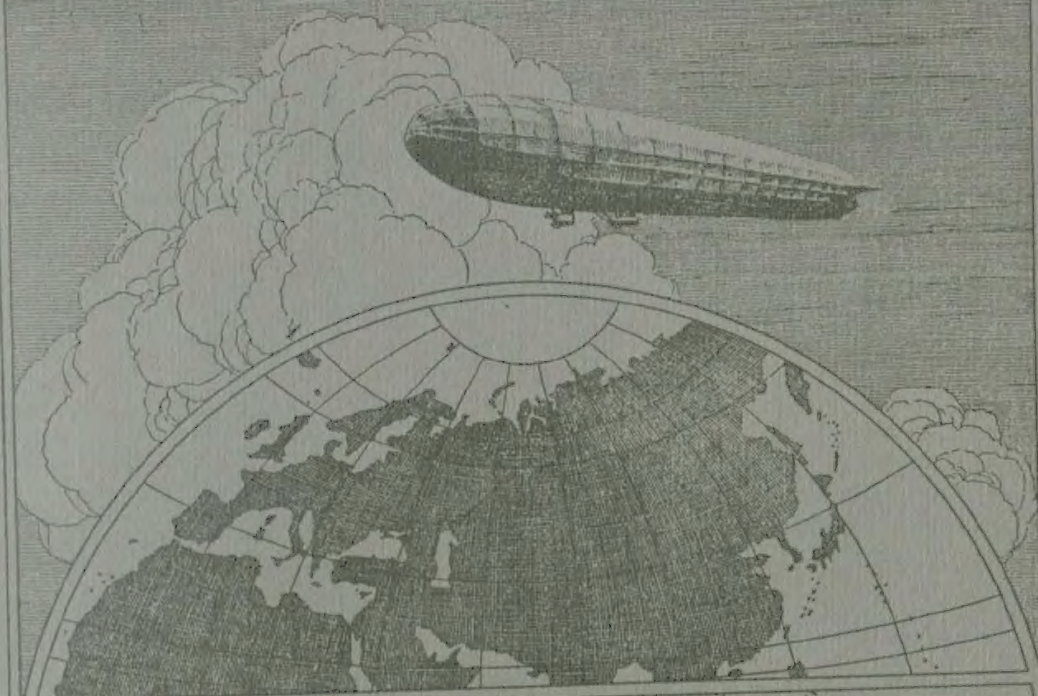




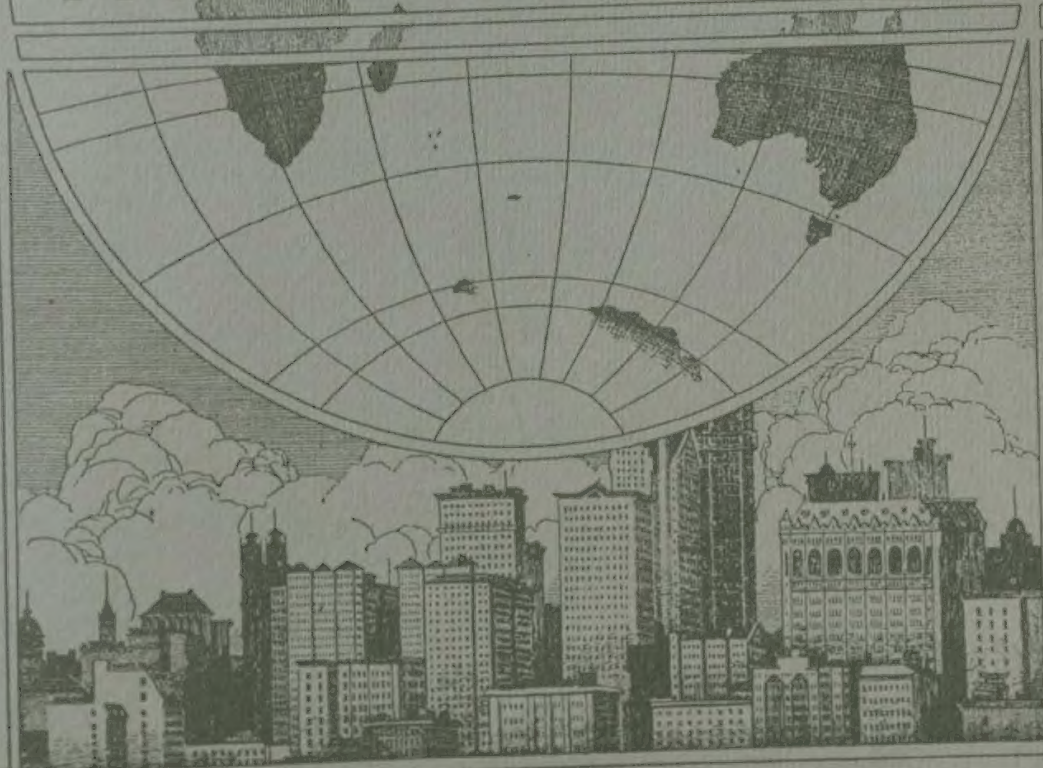


THE WORLD BOOK





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Ci-Cz Volume 4



The World Book Encyclopedia



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CIA. See Central Intelligence Agency.

Cibber, Colley (1671-1757), an English actor and playwright, won fame for his portrayal of eccentric characters. His first play, *Love's Last Shift*, was produced in 1696. *The Careless Husband* (1704) was his best comedy. In 1717, George I awarded him 200 guineas (£210) for his political comedy *The Nonjuror*, which supported the King's political view. George II appointed him poet laureate in 1730. Cibber's *Apology for the Life of Mr. Colley Cibber, Comedian* (1740), gives an account of the theatrical people of his day. Cibber was born in London.

Cibola, Seven Cities of, were seven legendary cities in what is now the Southwestern United States. Early Spanish explorers in Mexico believed the cities were rich in gold, silver, and precious jewels.

During the 1530's, Indians in northern Mexico told stories to the Spanish explorers about a rich civilization to the north. These stories led to an expedition in 1539 led by Marcos de Niza, a Spanish priest, to explore the land in the north.

Niza sent a black guide named Estevanico ahead to seek information from the Indians. They told Estevanico about seven rich cities in a land they called Cibola. Estevanico reached Hawikuh, the largest of six Zuñi villages near what is now Gallup, New Mexico, U.S.A. The Zuñis killed him outside Hawikuh.

Niza claimed that he saw Hawikuh from a distance and said the village appeared large and wealthy. His report led to an expedition headed by Francisco Coronado in 1540 to conquer the villages and claim their wealth for Spain. Coronado captured the six villages and called them Cibola. He found no riches there, however, and returned to Mexico in 1542.

See also Coronado, Francisco Vázquez de; Estevanico.

Cicada is a dark, heavy-bodied insect with four thin wings, which it can fold over its body like a roof. The head of the cicada is wide, with short, bristlelike feelers called *antennae*. Between its two main eyes there are three additional eyes, called *ocelli*. Its body is generally between 2 and 5 centimetres in length. The largest species of cicada have a wingspan of over 15 centimetres. Many types of cicadas secrete a waxy substance that helps them to keep dry in a damp or wet habitat.

Cicadas feed by sucking the sap of plants, and they live in trees and on other types of vegetation. There are about 1,500 species of cicadas. Most cicadas live in tropical and subtropical regions throughout the world.

The cicada is best known for the loud, rasping, repeated sounds made by the males. These sounds attract females, and they also bring together large numbers of males. Each kind of cicada has its own type of "song." The sound is made by the vibration of two *membranes* (thin sheets of skin), called *tymbals*, one on each side of the abdomen. The tymbals are made to vibrate by means of small muscles.

Development. A female cicada lays her eggs in the twigs of trees and shrubs. She deposits the eggs in small holes which she makes with a sawlike organ located near the tip of her abdomen. In a few weeks the eggs hatch to form young cicadas, called *nymphs*, which fall to the ground and enter the soil. The nymph uses its large front legs to burrow through the soil, and it lives by feeding on roots. A nymph remains in the soil



A cicada emerges as an adult insect after shedding its skin, right. The North American periodical cicada shown above takes 17 years to develop and is often called a 17-year locust.

until it is fully grown. This process may take several years, depending on the particular species. The nymph then crawls up out of the ground and climbs onto a tree or other object. It sheds its skin and emerges as the adult insect. Adult cicadas live for only a few weeks or months.

Types of cicadas. Australia has over 200 species of cicadas. Many of these are well known to children and have been given popular names. One of the first species to appear each summer is the *greengrocer* or *green Monday*. A yellow variety of this species is called the *yellow Monday*. The *floury miller* takes its name from a white colour on its body. The *red eye* is so named because of its bright-red eye spots. The *double drummer* is found along the east coast from southern Queensland to South Australia. Other cicadas include the *black prince*, the *fiddler*, and the *squeaker*. Scientists do not know exactly how long Australian cicadas remain in the soil as nymphs. They believe that the time ranges from about a year, for smaller species, to several years for the larger cicadas.

North American cicadas include two common groups: the *dog-day cicadas* and the *periodical cicadas*. Dog-day cicadas are large, dark, and often have greenish markings. They appear each year in July and August. It takes from four to seven years for a dog-day cicada to develop from an egg into an adult. However, some adults are seen each year because different *broods* (groups of young) develop at different times.

Periodical cicadas are dark, and have red eyes and wing veins. They appear in late May and early June. These cicadas take either 13 years or 17 years to develop from nymph to adult. Cicadas that take 17 years to develop are sometimes called 17-year locusts. During this long period of time the nymph sheds its skin seven times. The nymphs of the 17-year locusts build "chimneys" of earth over their burrows, and inside the chimneys they shed their skin for the last time. Several kinds of cicadas live in Europe. Most are found only in Continental Europe, with only one species, the so-called *mountain cicada*, found in the British Isles, in the New Forest, in southern England. The mountain cicada is about 2 centimetres long, and has a wingspan of about



Greengrocers, or *green Mondays*, are among the first species of cicadas to appear in Australia each summer.



Double drummers produce an ear-splitting noise with their *tymbals* (drums). Their tymbals have extra-large covers.

5 centimetres. It is believed to feed mainly on bracken.

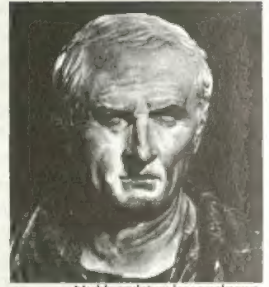
Scientific classification. Cicadas are insects that belong to the cicada family, Cicadidae, in the order Homoptera. The greengrocer is *Cyclochila australasiae*, the floury miller is *Abricta curvicauda*, the red eye is *Psaltoda moerens*, and the double drummer is *Thopha saccata*. The most common dog-day cicadas belong to the genus *Tibicen*. The periodical cicadas belong to the genus *Magicicada*. The mountain cicada is *Cicadetta montana*.

Cicely. See Sweet Cicely.

Cicero, Marcus Tullius (106-43 B.C.), was a great Roman orator and statesman. His written orations and philosophical and religious essays made him one of the most influential authors in Latin literature. In his writings, Cicero translated into Latin ideas and technical terms that had previously existed only in Greek. Cicero so improved Latin that it served as the international language of intellectual communication for centuries.

His life. Cicero was born of middle-class parents in Arpinum, Italy. He studied philosophy, rhetoric, and Greek and Latin literature in Rome, Athens, and Rhodes.

Cicero gained fame in 70 B.C., when he successfully prosecuted Gaius Verres, a corrupt former governor of Sicily. Cicero's victory in this trial earned him the approval of the Roman aristocracy. With the support of the aristocracy, Cicero attained the position of consul, Rome's highest elected political office, in 63 B.C.



Marble sculpture by an unknown Roman artist; Uffizi Gallery, Florence

Marcus Tullius Cicero

The First Triumvirate of Julius Caesar, Gnaeus Pompey, and Marcus Licinius Crassus banished Cicero from Rome in 58 B.C. because he opposed their rule. But Cicero was allowed to return to Rome in 57 B.C. The Second Triumvirate of Octavian (later the Emperor Augustus), Marcus Aemilius Lepidus, and Mark Antony would not tolerate Cicero's opposition. They had him killed.

His works. Cicero composed more than 100 orations. They are known for their precise choice of words; attention to grammatical structures; and skilful use of descriptions, narration, and prose rhythms. Two series of orations reflect Cicero's support for the republican form of government. In 63 B.C., he delivered four speeches against a Roman named Catiline who plotted to overthrow the Roman government. These speeches led to the defeat and death of Catiline and his followers (see *Catiline*). In 44 and 43 B.C., Cicero composed 14 speeches called the *Philippics*. In them, he attacked Mark Antony because he believed Antony intended to rule Rome with absolute power.

Cicero composed two major works on oratory, *Brutus* and *De Oratore*. He described the advantages of a serene old age in *De Senectute*, and he analysed friendship in *De Amicitia*. Cicero examined ethical behaviour in *De Finibus* and the nature of the gods in *De Natura Deorum*. Cicero discussed the attainment of happiness in *Tusculan Disputations* and one's duties in life in *De Officiis*. The influence of the Greek philosopher Plato appears in a book on law called *De Legibus* and a study of various forms of government called *De Republica*. Cicero's letters reveal his informal side and also provide valuable accounts of Roman life.

See also **Education** (Ancient Roman education); **Oratory**; **Latin literature** (The age of Cicero).

Cid, The (1040?-1099), also called *El Cid*, is one of Spain's national heroes. His real name was Rodrigo Díaz. *The Cid* comes from the Arabic *El Sayyid*, meaning *the lord*. The Cid served in the army of Sancho II of Castile. When Sancho was murdered, his hated brother Alfonso became king and banished The Cid. The Cid then gathered a small army and fought for anyone who hired him. In those times, the Moors held a large part of Spain. Soon The Cid gained great power and wealth. In 1094, he conquered Valencia from the Moors.

The Cid's story became a legend in *Poem of the Cid*, written about 1140, and in many later ballads. His story also inspired a drama by Pierre Corneille. The Cid was born near Burgos, and is buried there.

See also **Spanish literature** (Early medieval).

Cider is an alcoholic beverage made from the juice pressed out of apples. It is called *hard cider* in the United States. Most ciders contain 5 to 7 per cent alcohol. Cider is produced by grinding apples and squeezing out the juice with mechanical presses. The juice is then allowed to *ferment*. In this process, the juice is stored until yeasts convert sugar in the juice to alcohol. Cider may be made into *cider vinegar* by allowing bacteria to convert the alcohol to *acetic acid*. This acid gives the vinegar its sour taste. See **Vinegar**.

Cigar is a tight roll of dried tobacco used for smoking. Cigars range in size and shape from short, slim *cigarillos* to long, slender *panetellas* and large, fat *coronas*. The majority of cigars are made by machines, but the more expensive ones are hand rolled.

Most cigars consist of three parts and three types of tobacco. Folded *filler tobacco leaves* make up most of the body of a cigar. The filler is held together and surrounded by a *binder leaf*. A *wrapper leaf* is wound around the binder. Some inexpensive cigars have as their binders or wrappers *reconstituted tobacco sheets*. These sheets are made of coarse or damaged tobacco leaves that have been ground up and mixed with adhesive.

See also **Cuba** (picture: World-famous Havana cigars); **Smoking; Tobacco**.

Cigarette is a roll of shredded tobacco wrapped in paper. Most cigarettes contain blends of fluecured tobacco. Some cigarettes contain reconstituted sheet tobacco, which is made from ground leaf stems and leaf pieces. The tobacco blend is sprayed with flavouring and a chemical that preserves moisture. Most cigarettes have a filter at one end.

The first practical cigarette-making machine was invented in the early 1880s. Before that time, all cigarettes were rolled by hand.

During the 1960s, scientists reported that substances called *tars* and *nicotine*, which are inhaled during cigarette smoking, could cause lung cancer, heart disease, and other illnesses. Since then some countries have passed laws requiring manufacturers to label packages and cartons of cigarettes with a health warning. Radio and television commercials for cigarettes have also been banned.

During the 1970s, cigarettes with reduced levels of tars and nicotine became increasingly popular. Manufacturers reduced tars and nicotine through changes in cigarette design, including filtration, use of reconstituted sheet tobacco and tobacco substitutes, and a ventilation process that dilutes the cigarette smoke before it is inhaled.

See also **Smoking; Cancer** (Causes of cancer); **Filter; Nicotine; Tobacco**.

Cilento is the family name of three distinguished Australians, father, mother, and daughter.

Sir Raphael West Cilento (1893-1985), a barrister, became the director of the Australian Institute of Tropical Medicine. He was born at Jamestown, in South Australia, and studied at Adelaide University. He directed the UN Division of Refugees in 1946.

Phyllis Dorothy, Lady Cilento (1894-1987), founded the Queensland Mothercraft Association. She was a doctor and served as a medical officer in Malaya and at Rabaul. She was born in Sydney.

Diane Cilento (1932-) became a stage and film actress. She was born at Toowoomba, in Queensland, and studied acting at the American Academy of Dramatic Art in New York City and the Royal Academy of Dramatic Art in London. In 1956, she won the Daniel Blum Award for her acting in Jean Giraudoux's *Tiger at the Gates*, in London.

Cilia are tiny, hairlike structures that project from certain kinds of cells. Cilia are slender and move constantly. They are so small that they can be seen only under a microscope.

In higher animals, cilia are found in cells of the membranes of the nose, the ear, and the tubes leading toward the lungs. The wavy motion of the cilia in these organs pushes out dust, bacteria, and mucus, and keeps the passages clean. In many water-living animals, cilia-containing cells fan water containing food and oxygen into the animal. Many one-celled organisms have cilia that serve as sense organs and provide a means of locomotion.

See also **Protozoan** (Ciliates).

Ciliate. See **Protozoan** (Ciliates).

Cimabue, Giovanni (1240?-1302?), an Italian painter, was the first famous painter from the city of Florence. He began an era of famous Florentine painters that included Leonardo da Vinci.

Cimabue's art does not show obvious originality. He painted in a traditional style based on the medieval art of the Byzantine Empire, and used little of the realism of the later Florentine painters. His faces and figures are the formalized types of the Byzantine period. But his works have great personal force and effect, even though the forms are traditional.

Five or six of Cimabue's works exist today. The most famous include the altarpiece of the *Madonna and Child with Angels* in the Uffizi Gallery in Florence, and fres-



Tempera on wood (1295?); formerly in the Church of Santa Croce, Florence, now in the Uffizi Gallery, Florence

Cimabue's Crucifixion shows the influence of Byzantine art. A 1966 flood in Florence, Italy, partially destroyed the painting.

4 Cimmerians

coes of a similar subject and of the Crucifixion in the church of Saint Francis at Assisi. These works show great power and grandeur, and the *Crucifixion* combines those qualities with dramatic impact.

See also **Renaissance** (picture: Medieval and Renaissance art).

Cimmerians were nomads who lived in what is now southern Ukraine from about 1200 B.C. to 700 B.C. They inhabited an area north of the Caucasus Mountains, near the Black Sea. They used horses and the bow and arrow and were known as fierce warriors. They were one of the first nomadic groups to invade Asia Minor (now Turkey) from the north.

Scholars have not found written records left by the Cimmerians and know little about the group. The Greek historian Herodotus wrote that they were driven from their homeland into Asia Minor by nomads called the Scythians. About 700 B.C., the Cimmerians fought the Assyrians and destroyed the kingdom of Phrygia in what is now central Turkey. About 690 B.C., they began to raid Lydia, a great commercial centre in what is now western Turkey. The Cimmerians were defeated by the Assyrians during the mid-600's B.C.

Cimon (507?-449 B.C.) was a military and political leader in ancient Athens. He commanded the fleet that drove the Persians from Europe in 479 B.C., during the Persian wars.

Cimon helped form the Delian League, which tried unsuccessfully to unite all Greeks. Cimon was the leader of the powerful aristocrats in Athens. The aristocrats opposed reforms that Pericles, leader of the democrats, wished to make. When the democrats came to power in 461 B.C., Pericles forced Cimon into exile. Cimon returned in 451 B.C. and arranged a truce between Athens and Sparta.

Cinchona, also spelled *chinchona*, is a group of valuable South American trees and shrubs. Cinchona bark is used to make the drugs quinine and cinchona, with which doctors treat malaria. The cinchona is an evergreen. Cinchona plants were first found in Peru and Ecuador. They are now grown in India, Sri Lanka, eastern Asia, tropical America, and parts of Africa. The flowers are usually fragrant. They vary from rose-purple to greenish-white and look like lilac blossoms.

Scientific classification. Cinchona belongs to the madder family, Rubiaceae. Cinchona makes up the genus *Cinchona*.

See also **Bitters**; **Quinine**.

Cincinnati (pop. 364,040; met. area pop. 1,130,324), in Ohio, is a major industrial and commercial centre of the Midwestern region of the United States. It leads the world in the production of soap and playing cards and produces more machine tools than any other city in the United States. Cincinnati lies on the Ohio River in southwestern Ohio.

Cincinnati covers 205 square kilometres. The Cincinnati metropolitan area occupies 5,618 square kilometres and extends into the neighbouring states of Indiana and Kentucky. A flat plain called the *basin* extends north into Cincinnati from the Ohio riverfront. In this area are the city's central business district, some manufacturing sections, and several old residential areas. Hills surround the basin on three sides.

Cincinnati's port handles about 14 million metric tons of cargo yearly. Much of the cargo is *bituminous* (soft)

coal. River trade accounted for much of Cincinnati's growth during the 1800's, but since then its economy has relied mainly on manufacturing. Many commercial airlines use the Greater Cincinnati International Airport, which lies 16 kilometres outside the city.

Cincinnatus, Lucius Quinctius (519?-439? B.C.), a Roman statesman and general, was a legendary model of patriotism. In 458 B.C., Rome was threatened by the Aequi, a tribe of central Italy. The Senate sent messengers to tell Cincinnatus that he had been named commander in chief. The messengers found him ploughing his fields. He joined the army at once, and marched to rescue a *consul* (chief government official) who was in great danger. Cincinnatus defeated the enemy, marched his army back to Rome, and resigned. He returned to his farm 16 days after he took office.

George Washington was sometimes called the "American Cincinnatus" because he also held his office only as long as necessary. After the American Revolution, a group of former officers formed the patriotic Society of the Cincinnati. The city of Cincinnati, Ohio, U.S.A., is named after this organization.

Cinema. See **Film industry**.

Cineraria is a group of small herbs that belong to the composite family. They grow wild in the Canary Islands, but are cultivated throughout the world. The flowers are usually purple, red, or purple and white, with dark centres. Cinerarias are easily grown from seed. They make fine window plants, but must be grown at a temperature less than 18°C.

Scientific classification.

Cinerarias belong to the composite family, Compositae (Asteraceae). The florist's cineraria is classified as *Senecio cruentus*.



See also **Composite family**.

Cineraria blossoms

Cinnabar is the most important ore of mercury. It provides most of the world's supply of mercury. Cinnabar, a bright red mineral, contains sulphur as well as mercury. It is known to scientists as *sulphide of mercury* and its chemical symbol is HgS. Cinnabar usually occurs in earthy masses or scattered in opal. It rarely appears as crystals. The ore is found mostly near the earth's surface, close to volcanic rocks and hot springs. Deposits occur in China, Slovenia, Spain, and the United States.

See also **Mercury** (element); **Mineral** (picture).

Cinnamon is a popular spice used in cooking and for flavouring sweets and preserves. It comes from the inner bark of the cinnamon tree. The tree grows in Sri Lanka, the principal source of the spice, and in Brazil, India, Jamaica, Java, Madagascar, and Martinique. The cinnamon tree grows as high as 9 metres and has oval leaves and tiny yellow flowers. The fruit of the cinnamon tree looks like an acorn.

Workers cut off the tops of cinnamon trees near the lower buds so that strong, straight shoots grow up from the base. The shoots are gathered, and the inner bark is peeled off. The bark then turns brown and curls up as it

dries. The dried bark is sold as stick cinnamon or is ground up to make powdered cinnamon. Oil of cinnamon is made from the fruit, leaves, and roots of the tree.

An oil similar to that of the cinnamon tree comes from a related plant, commonly called cassia. Cassia oil and bark are often used instead of cinnamon.

Scientific classification.

The cinnamon tree belongs to the laurel family, *Lauraceae*. It is *Cinnamomum zeylanicum*. The cassia plant is *C. cassia*.



Cinnamon is sold in both powdered and stick form.

Cinque ports are towns along the southeastern coast of England where, in the past, the monarch was provided with free ships and crew for 15 days each year. In return, the ports were allowed certain privileges. By 1100, shortly after the Norman Conquest, there were five of these ports—at Dover, Sandwich, Romney, Hythe, and Hastings. They were known as the *cinque* (pronounced *sink*) ports, from the French word for *five*. Rye and Winchelsea were soon added, to make seven in all. As the ports prospered, lesser ports were allowed to share the privileges of the first five. There were 32 ports in the mid-1500's. The cinque ports declined in later years because most of their harbours silted up. They surrendered their charters in 1685, and by 1835, had lost all their privileges. A warden of the cinque ports has been appointed since 1268. The title *Lord Warden of the Cinque Ports* survives as an honorary office. Queen Elizabeth, the Queen Mother, was appointed to this post in 1978.

Cinquefoil is any one of a group of plants that belong to the rose family. About 250 kinds of cinquefoils grow in most cool and cold regions throughout the world. These herblike plants may grow erect, or close to the ground in creeping fashion. The leaves have three, five, or more leaflets. Because of the shape of their leaves, the plants are sometimes called *five-finger* or *false strawberry*. The bright yellow or white flowers of the cinquefoil grow in loose clusters. Some of the types of cinquefoil are troublesome weeds. See also **Flower** (picture: Flowers of the Arctic tundra).

Scientific classification. The cinquefoils are members of the rose family, *Rosaceae*. They make up the genus *Potentilla*.



The cinquefoil grows in most cold regions.

Cipher. See **Codes and ciphers**.

Circadian rhythm. See **Biological clock**.

Circe, a beautiful enchantress in Greek mythology, had the power to turn men into beasts. She lived on an island in the Mediterranean Sea. When Odysseus (Ulysses in Latin) landed on her island, Circe turned most of his men into pigs and drove them into a pigsty. But the god Hermes had given Odysseus a magic herb which protected him from Circe's power (see **Hermes**; **Ulysses**). Odysseus forced Circe to give his men their human form again.

After that, Circe became friendly. She loved Odysseus and persuaded him to stay with her on the island for a year. When he prepared to leave, she warned him about the dangers that awaited him, and told him how to overcome them. For example, Circe told Odysseus that by plugging his sailors' ears with wax he could safely pass the island where the Sirens lived (see **Siren**). The wax was to prevent the sailors from hearing the singing of the Sirens, which was likely to lure them to the island and cause their ship to be wrecked on the rocks.

See also **Odyssey**; **Scylla**.

Circle is a closed curve on a plane. All points of the curve are the same distance from a point that lies within the curve. This point is called the *centre*. There are 360 degrees in a circle.

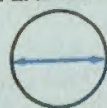
Many common objects have a circular shape, including rings, hoops, and wheels. You can easily draw a circle with an instrument called a *compass*. A compass looks like a pair of scissors with a pencil where one point should be. To draw a circle, place the point of the compass at the point chosen as the centre, and rotate the pencil around it.

Parts of a circle. Sometimes people use the words *disc* or *circle* to mean the area inside the curve. They call the curve itself the *circumference*. The length of the curve is also called the circumference. An *arc* is any connected part of the circumference.

A *chord* is a straight line between two points on the circumference of a circle. If a chord goes through the centre, it forms a *diameter*. A diameter is the longest chord of a circle, and divides the circle into two equal parts called *semicircles*.

The *radius* is the distance from the centre to the circumference. It equals half the length of a diameter. The word *radius* is also used to mean any line that joins the centre to the circumference.

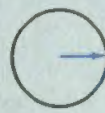
Parts of a circle



Diameter



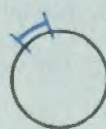
Circumference



Radius



Chord



Arc



Sector

6 Circuit, Electric

A *secant* is a straight line that intersects a circle at two points. A line that just touches the circle, or meets the circle at just one point, is called a *tangent*. If you move a secant away from the centre of the circle so that it always lies parallel to its previous position, the two points at which it touches the circle will get closer to each other. When the points come together, the secant has reached the position of a tangent. The point where the tangent touches the circle is the *point of tangency*. The radius at the point of tangency makes a right angle with the tangent.

The use of π . The Greek letter π (written π) stands for the number by which the diameter of a circle (d) must be multiplied to obtain the circumference (c). That is, $c = \pi d$ or $2\pi r$, where r is the radius. The area of a circle (A) is given by the formula $A = \pi r^2$.

You cannot write π exactly as a decimal. But by increasing the number of digits, you can get a number as near to it as you want. Common approximations used for π include $\frac{22}{7}$, 3.14, 3.1416, and 3.14159.

History. The ancient Chinese used 3 as the value of π . About 1650 B.C., the Egyptians improved on the approximation. The astronomer Ptolemy of Alexandria calculated a value for π that was the equivalent of 3.1416. After decimals came into use in the 1600's, an exact value for π , with either repeating or a limited number of decimal places, was sought. Mathematicians now know that this is impossible.

See also Degree; Pi; Radian.

Circuit, Electric. See Electric circuit.

Circuit breaker is an automatic switch. It protects electric motors, household wiring, long-distance power lines, and other electric circuits against damage caused by too much electric current. Too much current may flow in a circuit as a result either of a fault in the circuit or of an outside event, such as lightning.

Every circuit breaker is designed to allow a specific maximum amount of electric current to pass. If the current exceeds this limit, an automatic mechanism inside the circuit breaker throws open a *set of contacts* (switch) and stops the current. Mechanisms used to open the switch include electromagnets and temperature-sensitive devices.

As the switch opens, an electric arc leaps across the open contacts. Electricity continues to flow through this arc until it is extinguished. In an *oil circuit breaker*, the switch is immersed in an oil that extinguishes the electric arc. In an *air-blast circuit breaker*, a blast of compressed air blows out the arc. In a *magnetic arc-suppression circuit breaker*, a magnetic field deflects and breaks the arc.

A circuit breaker called an *earth leakage circuit breaker* (ELCB) helps prevent electric shocks. Most electric shocks occur when people use faulty appliances in which exposed metal parts have become *live*. If the metal is touched, a current flows through the person's body to the earth. The ELCB detects this earth leakage current and automatically shuts off the electricity to the defective appliance. The ELCB is a sensitive device designed to work on currents that are too small to activate an ordinary circuit breaker.

Some circuit breakers are about as small as an ordinary light switch. But some are as large as a small two-storey house. A large circuit breaker can interrupt cur-

rents up to 40,000 amperes at 345,000 volts. It can open a circuit in less than $\frac{1}{30}$ of a second, and reclose it in less than $\frac{1}{3}$ of a second.

Circulation. See Circulatory system.

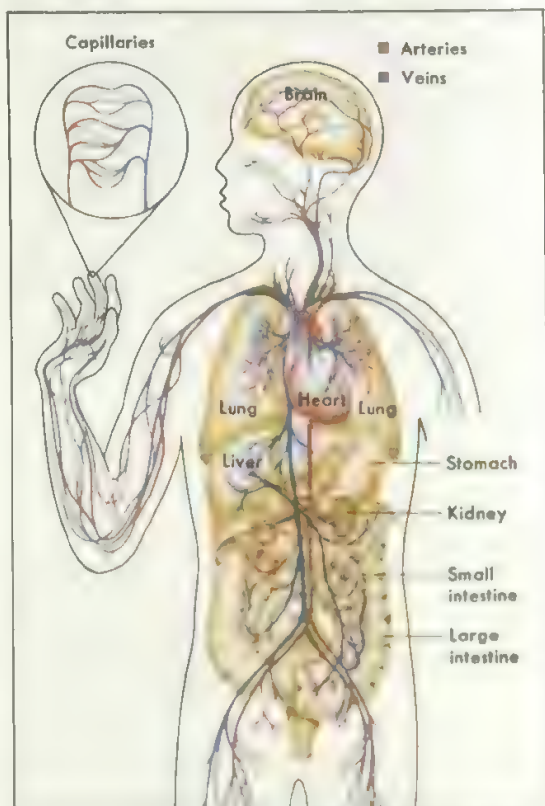
Circulatory system is a network that carries blood throughout the body. All animals except the simplest kinds have some type of circulatory system.

In some *invertebrates* (animals without a backbone), the circulatory system consists of a simple network of tubes and hollow spaces. Other invertebrates have pumplike structures that send blood through a system of blood vessels. In human beings and other *vertebrates* (animals with a backbone), the circulatory system consists primarily of a pumping organ—the heart—and a network of blood vessels. These vessels carry blood throughout the body.

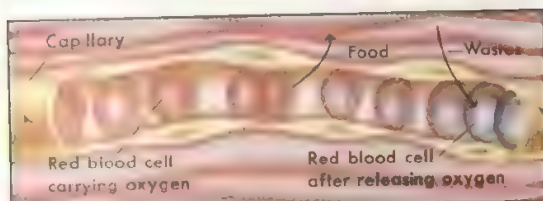
The human circulatory system supplies the cells of the body with the food and oxygen they need to survive. At the same time, it carries carbon dioxide and other wastes away from the cells. The circulatory system also helps regulate the temperature of the body and carries substances that protect the body from disease. In addition, the system transports chemical substances called *hormones*, which help regulate the activities of various parts of the body. This article discusses mainly the human circulatory system.

The human circulatory system

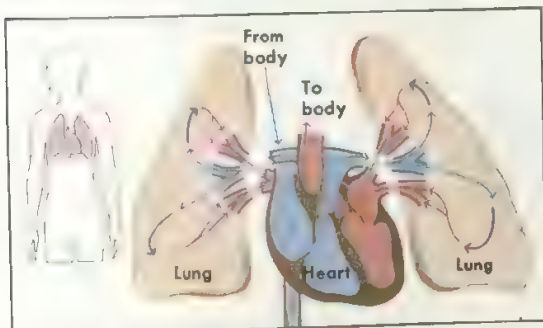
A person's circulatory system consists chiefly of a pump—the heart—and a network of blood vessels. These vessels—arteries, veins, and capillaries—carry blood throughout the body.



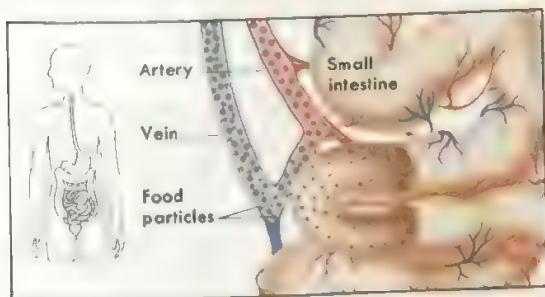
Some functions of the circulatory system



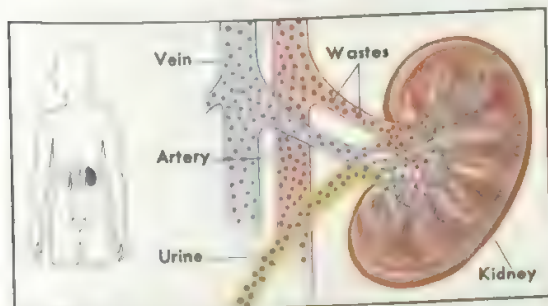
In maintaining body tissues. The circulatory system supplies tissues of the body with essential food and oxygen, and carries away carbon dioxide and other wastes. Substances leave and enter the bloodstream through thin capillary walls.



In respiration. Blood carrying carbon dioxide, *blue*, flows to the heart. The heart pumps it to the lungs, where it gives up carbon dioxide and picks up oxygen. The oxygen-rich blood, *red*, returns to the heart and is pumped to all parts of the body.



In nutrition. The circulatory system carries digested food particles to the cells of the body. These particles enter the bloodstream through the walls of the small intestine.



In removal of wastes. Waste products from body tissues are carried by the blood to the kidneys. The kidneys filter out these substances and expel them in the urine.

Parts of the circulatory system

The human circulatory system has three main parts: (1) the heart, (2) the blood vessels, and (3) the blood. A watery fluid called *lymph*, and the vessels that carry it, are sometimes considered a part of the circulatory system (see *Lymphatic system*).

The heart is a hollow, muscular organ that pumps blood. It consists of two pumps that lie side by side. These pumps relax when taking in blood and contract as they send out blood. The left side of the heart is a stronger pump than the right side. The stronger pump receives blood from the lungs and sends it to cells throughout the body. The weaker pump receives blood from the cells throughout the body and sends the blood to the lungs.

The blood vessels form a complicated system of connecting tubes throughout the body. There are three major types of these vessels. *Arteries* carry blood from the heart. *Veins* return blood to the heart. *Capillaries* are extremely tiny vessels that connect the arteries and the veins.

The blood consists chiefly of a liquid called *plasma* and three kinds of solid particles known as *formed elements*. Plasma is made up mostly of water, but it also contains proteins, minerals, and other substances. The three types of formed elements are called *red blood cells*, *white blood cells*, and *platelets*. Red blood cells carry oxygen and carbon dioxide throughout the body. White blood cells help protect the body from disease. Platelets release substances that enable blood to clot. Platelets thus aid in preventing the loss of blood from injured vessels.

Functions of the circulatory system

The circulatory system performs many vital functions. It plays an important role in respiration. The circulatory system is also important in nutrition, in the removal of wastes and poisons, and in several other body processes.

In respiration. The circulatory system plays a part in respiration by delivering oxygen to the cells and removing carbon dioxide from them. During this process, the blood follows two routes called the *systemic circulation* and the *pulmonary circulation*.

From the left side of the heart, blood full of oxygen is pumped into the systemic circulation. This blood leaves the heart through the *aorta*, the main artery of the body. A number of major arteries branch off the aorta. These arteries, in turn, branch into smaller and smaller vessels, finally emptying into the tiny capillaries. There, oxygen leaves the blood and enters the tissues through the thin capillary walls. In a similar way, carbon dioxide leaves the tissues and enters the blood. The blood, now carrying carbon dioxide, leaves the capillaries and flows through larger and larger veins. Eventually, the blood enters the right side of the heart through two large veins—the *superior vena cava*, which carries blood from the head and arms, and the *inferior vena cava*, which carries blood from the trunk and legs.

From the right side of the heart, the blood is pumped into the pulmonary circulation. *Pulmonary arteries* carry the blood that contains carbon dioxide to capillaries in the lungs. The carbon dioxide passes through the capil-

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lary walls into the lungs and is then exhaled. Oxygen that has been inhaled passes from the lungs into the blood in a similar way. The blood returns through the *pulmonary veins* to the left side of the heart and begins its journey again.

In nutrition. The circulatory system carries digested food substances to the cells of the body. These nutrients enter the bloodstream by passing through the walls of the small intestine into the capillaries. The blood then carries most of the nutrients to the liver.

The liver removes certain nutrients from the blood and stores them. It later releases the nutrients into the blood when the body needs them. The liver also changes some nutrients into substances needed by the body. Blood leaving the liver contains nutrients that the cells use in the production of energy, enzymes, and new building materials for the body.

In removal of wastes and poisons. The circulatory system helps dispose of waste products and poisons that would harm the body if they accumulated. These substances include carbon dioxide, salts, and *ammonia*, a by-product of the cell's use of protein.

The liver removes *ammonia* and other wastes, and various poisons that enter the body through the digestive system. The liver converts the wastes and poisons into water-soluble substances, which are carried by the blood to the kidneys. The kidneys filter out these and other water-soluble wastes and expel them from the body in urine.

Other functions. The circulatory system helps protect the body from disease. White blood cells engulf and destroy bacteria, viruses, and other harmful invaders. As the blood circulates, it also helps keep the body temperature stable by absorbing heat from the cells' production of energy.

If the temperature of the body begins to rise, the flow of blood into vessels in the skin increases. The heat from cells deep in the body is thus carried to the skin, from where it passes out of the body. If the temperature of the body begins to drop, the flow of blood to the skin is restricted. This action enables the body to retain as much heat as possible.

The circulatory system also carries hormones. These chemical substances affect or control the activities of various organs and tissues. Hormones are produced by the endocrine glands, including the thyroid, pituitary, adrenal, and sex glands. These glands release their hormones into the bloodstream.

Disorders of the circulatory system

The circulatory system can be damaged by disease or injury. One of the most common diseases of the system is *arteriosclerosis*, which results from the accumulation of fatty deposits in the arteries. Such deposits stiffen and thicken the walls of the arteries. As a result, the flow of blood is restricted. In some cases, blood clots develop in vessels affected by *arteriosclerosis*. Such clots may lead to a heart attack or a *stroke*, a condition in which the brain does not receive enough blood.

Another disease, *hypertension*, commonly called *high blood pressure*, is often associated with *arteriosclerosis*. *Hypertension* makes the heart work harder and may lead to such complications as a heart attack, a stroke, or kidney failure.

Treatment for *arteriosclerosis* and *hypertension* includes rest, exercise, and changes in the diet. Doctors may prescribe various drugs to lower the blood pressure, strengthen the heart, or prevent infection and blood clots. In extreme cases, a surgeon may remove clots or replace one or more diseased blood vessels.

Other disorders of the circulatory system result from damage or defects in the heart or blood vessels. For example, *rheumatic fever* may harm or destroy the valves that control the flow of blood through the heart. Incomplete development of the heart or its blood vessels before birth may produce defects called *congenital heart disorders*. Some cases of damage or defects can be corrected by surgery.

The circulatory system in other animals

Vertebrates all have a *closed* circulatory system. In this type of system, the blood flows only in the vessels and remains separate from the fluid in the body tissues. Mammals—including human beings—and birds have a heart with two separate pumps. In these animals, the blood in the systemic and pulmonary circulations almost always remains separate. In amphibians and most reptiles, the pumps of the heart are only partly separated, and the systemic and pulmonary blood mixes together somewhat. In fish, the heart has only one pump. The pump collects the blood and sends it to the gills and then to the rest of the fish's body.

Invertebrates have circulatory systems that range from complex to simple. Some invertebrates, such as earthworms and octopuses, have a closed circulatory system. Other invertebrates have an *open* circulatory system, in which the blood is only partially confined to the vessels. It fills the hollow spaces of the body as well. Animals with an open circulatory system include insects, spiders, and most shellfish.

In many invertebrates, the blood is pumped by contracting vessels or by *pumping centres* (contracting portions of vessels), or by both. Among insects, for example, the "heart" consists of an internal contracting vessel that extends almost the length of the back.

The simplest animals with a true circulatory system include certain kinds of worms. Earthworms, leeches, and a variety of sea worms have contracting vessels that pump the blood. A group of simpler worms, called *ribbon worms* or *proboscis worms*, have a circulatory system with no pumping centres and no contracting vessels. The movements of the animal keep the blood flowing through the body.

See also **Blood; Heart; Lung; Lymphatic system**; and their *Related articles*.

Circumcision is the surgical removal of the skin that covers the tip of the penis. An uncircumcised penis has a loose fold of skin called the *foreskin* or *prepuce* that covers the *glans* (tip of the penis). A surgeon removes the foreskin in a simple operation that consists of cutting around the penis where the foreskin is attached. The word *circumcise* means *cut around*.

Most circumcisions are performed shortly after birth. The surgeon obtains the parents' permission before performing this minor surgery. When circumcision is performed on newborn boys, an *anaesthetic* (painkilling drug) is generally not used. Older boys and adult males receive an anaesthetic and may need to stay in hospital

for a few days after the operation. In a less frequently used circumcision method called *electrocautery*, an electrically heated needle is used to cut the foreskin or to stop bleeding that occurs. However, electrocautery has caused serious injury to some patients, and many doctors object to its use.

At one time, most doctors felt that circumcision of the newborn made the glans easier to clean and thus helped to prevent infections of the penis. They also believed that circumcision reduced the risk of developing cancer of the penis. Research now indicates that uncircumcised males are more susceptible to infections of the *urinary tract*, the organs and tubes that produce and eliminate urine. But many doctors still maintain that proper hygiene can be just as effective in preventing such infections and that routine circumcision is not medically necessary.

Today, circumcision is performed largely for cultural or religious reasons. Many parents choose to have their sons circumcised because the father is circumcised, or because the operation is common where they live. Many parents feel it would be undesirable for the child if his penis did not look like that of other males.

For thousands of years, various religious rituals have included circumcision. The ancient Jews, Egyptians, and other Middle Eastern peoples performed it when a boy was maturing into a young man. Circumcision was a sign that the youth should be ready to assume his religious duties in the adult community.

The Old Testament of the Bible includes many references to circumcision as a sign of initiation and membership into the Jewish community. Circumcision became an important rite of Judaism. A traditional Jewish circumcision takes place on the eighth day after birth.

Muslims also regard circumcision as part of their religion. Some Muslims celebrate circumcisions with feasts and parades. Muslim boys are circumcised some time between infancy and about 14 years of age.

A procedure called *female circumcision* is practised in some developing countries. Female circumcision involves the partial or complete removal of the *clitoris*, a sensitive part of the female genitals. The operation, which is frequently performed by unskilled people, is done for cultural reasons.

Circumference. See Circle.

Circumstantial evidence. See Evidence.

Circus is a variety show that features daring and graceful acts by trapeze artists, acrobats, horseback riders, animal trainers, and other performers. Trained animals play an important part in most circuses. Clowns in funny clothes provide comedy for the show while the circus band and performers in bright costumes add to the colour and excitement.

The word *circus* comes from a Latin word for *circle* or *oval*. For thousands of years, circus-type entertainments have been put on in circular structures. Today, circuses are held in tents and arenas.

At the circus

Traditionally, circus shows are held in large canvas tents. The main circus acts appear in the *big top*, the largest tent. Some big circuses, such as The Ringling Brothers and Barnum & Bailey Circus in the United States of America, now hold their shows in huge arenas indoors. The Moscow State Circus in Russia has always performed indoors as well as in tents.

The circus performance may include a parade called a *spectacle*. As the band plays a lively tune, circus per-



A colourful circus parade called the *spectacle* begins the show. Animals and circus performers march around the arena while the circus band, shown at the far end, plays lively music.

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formers and animals march around the arena. The elephants wear bright velvet or satin ornaments. Beautiful horses with shiny coats prance by proudly. Sometimes dozens of dancers in colourful costumes take part.

As the circus performers pass in review, the clowns make the audience laugh with their funny tricks. A dozen of them may pile out of a tiny car. Others may set a toy house on fire, then put out the flames with water from a miniature fire truck.

Most circus acts take place in round areas called *rings*. In one act, elephants stand on their hind legs and dance. In another, trained seals balance big rubber balls on their noses. Trained horses *canter*, or gallop gently, in a circle while riders jump from horse to horse. A family of riders stand on each other's shoulders on the backs of horses cantering side by side around the ring. A lion trainer enters a cage and cracks a whip. The big cats leap onto platforms upon command.

Some performers hang by their teeth from a rope and twirl around. Others, called *flyers*, leap through the air from one trapeze to another. They perform daring somersaults in the air before being caught by other members of the act. Other acts feature performers on the high wire, riding bicycles or doing acrobatics.

The circus band plays throughout the show. The band helps keep the acts running on time. By playing faster or slower, or by changing tunes, it signals to the performers when to finish the various parts of their acts. The music keeps up the feeling of excitement and pride in the performance that is as old as the circus itself.

Many people visit the menagerie to see the circus animals up close. Fierce lions and tigers pace back and forth in cages. Elephants stick out their trunks for peanuts. Monkeys jump and climb around their cages, chattering at the crowds.

Life in the circus

On tour. Most circuses travel by road, giving performances for a few days at a time in different places. During the late 1800's, large circuses in the United



Clowns in funny costumes and comic makeup entertain the audience with their playful antics and humorous stunts. The clowns often perform between acts.



Daring aerialists perform acrobatic feats high above the ground. One member of this team hangs from a trapeze, ready to catch his partner.



Wild animal acts provide great excitement for audiences. These tigers do tricks on command from their trainer. To protect the spectators, the tigers perform inside a wire cage.



Performing elephants are among the most popular attractions at many circuses. Trainers work for months teaching the huge animals difficult tricks.

States began to travel by railway. Special wagons and methods of loading were designed to pack and transport the animals, tents, and other equipment, as well as the performers. Wirth's circus in Australia, and Bertram Mills in the United Kingdom, used trains during the early 1900's, but most circuses outside America continued to travel by road.

On the shows that travel by road, most performers and workers live in caravans. Most performers prepare their own meals. The circus provides meals for the workers. A circus may also have its own blacksmith, barber, post office, and doctor and first-aid unit.

Before the circus comes to town, publicity people put up brightly coloured posters advertising the show. As soon as the circus arrives, workers begin to unload the equipment and set it up. If the circus uses tents, machines help unload great sections of canvas and drive the tent stakes into the ground. The workers have plenty to do even if the show is given in a building. After the

last performance on the final day, they quickly take everything down so it can be moved on to the next place.

Circus people work together like members of a huge family. Sometimes even the stars of the show perform in acts besides their own, or help with the everyday circus chores. For example, a trapeze artist may ride an elephant in the elephant act. A clown may spend some time every day brushing the circus horses.

Circus stars often teach their acts to their children. When the children grow up, they carry on the traditional family acts. Sometimes aunts, uncles, cousins, and other relatives become members of a family act.

Winter quarters. Most circuses travel only in the summer months and spend the winter in permanent buildings. But the busy life of the circus people does not slow down for long. Soon they are hard at work preparing for the next season. Wild animal trainers begin to train new jungle beasts. The flyers, acrobats, and other circus stars practise every day. The clowns plan new



Jugglers perform a tricky balancing act while tossing clubs back and forth. Skilled jugglers use a variety of objects, including delicate dishes and flaming torches.



A high-wire team performs on a cable far above the ground. The men on the bottom use poles to help keep their balance.



At the winter quarters of a circus, the art of applying makeup is demonstrated at a school for clowns.

stunts. Other circus workers design and sew costumes, purchase and mend equipment, and look after animals.

The circus winter quarters look like a small city. They have streets and shops, large storehouses, barns for the animals, and a ring where the circus stars practise. Many circus people live nearby in houses and caravans.

Famous circus performers

Many circus stars have become world famous. Poodles Hanneford and his family combined clowning with skilful bareback riding. Antoinette Concello became the

first woman to perform a triple somersault, the most difficult trapeze stunt. Clyde Beatty and Mabel Stark became known for their acts with wild animals. Gunther Gebel-Williams also gained fame as an animal trainer. Famous circus clowns have included Felix Adler, Otto Griebling, Lou Jacobs, and Emmett Kelly.

Franz Furstner, known as "Unus," stood on top of a pole on one finger. His daughter, Vicki, became famous for doing one-armed swings while hanging from a rope high in the air. Chrys Holt performed a juggling act while hanging by her hair at the top of the tent. Con Col-



Horseback riders perform dangerous acrobatic stunts while their horses canter around the ring. Such acts require careful teamwork between the horses and the acrobats.

leano was an Australian wire-walker best known in Europe and the United States for his Spanish dancing on the high wire. English performers are best known for their bareback riding, inspired by Andrew Ducrow who, in the early 1800's, trained horses to pass through his legs while he stood on two other cantering horses.

Some circus acts are dangerous, and the performers risk their lives at each show. Lillian Leitzel became world famous for her breathtaking aerial act. She hung by one wrist from a rope and swung her body around and around. She fell to her death during a performance in 1931 when part of her equipment snapped. The Wallendas, a famous circus family, developed the most spectacular high wire act in history. Seven of them stood on each other's shoulders, then walked along the wire. Four members of the act were killed and one was paralysed in falls from the high wire during the 1960's and 1970's.

History

Circus-type acts and performers go back thousands of years. In ancient Rome, games featured chariot races and men standing on the bare backs of two horses racing around a track. During the Middle Ages, various performers and clowns called *jesters* entertained on the streets and in the royal courts of Europe.

The modern circus developed in England. In 1768, Philip Astley staged a show that featured trick horseback riding and live music. Astley later added other acts, such as acrobats, a clown, and a band to his performances. He presented his show in a circular structure and it became popularly known as "Astley's Circus."

The first Astley-type circus in America was opened by John Bill Ricketts in Philadelphia in 1793. Ricketts' circus featured a rope walker, a clown, and riding acts. Most early circuses had acts similar to the Ricketts' circus.

During the late 1700's and early 1800's, travelling menageries of exotic animals toured parts of the Northeastern United States. People flocked to see exhibits of animals that were new to them. Later, menageries appeared in Europe and Australia. Menageries travelled by horse and wagon, and were often shown in a barn or canvas-wall enclosure. Circuses adopted many characteristics of these shows. By 1835, many circus acts in-

cluded wild animal exhibits. By 1850, circuses already had many of the elements that are associated with them today. These included brass bands, bright costumes, and colourful circus posters.

For many years, circuses paraded through the streets before a performance. The brightly painted wagons, saddle horses, and elephants made a colourful sight. The traditional circus wagons originated in England in the 1850's. The circus band played spirited music. But the parades had to be discontinued in most places because city streets became crowded with traffic.

Many circuses once featured a *side show*, which was a smaller, separate show near the big top. The side show offered such exhibits as a snake charmer, a sword swallower, a fire eater, and a tattooed man. Also on display were such curiosities as midgets, giants, a bearded lady, or a fat lady. Circus people called *talkers* told the crowd about the wonders to be seen in the side shows. Side shows were popular in tent circuses.

The golden age of the circus began about 1870. Each circus boasted it was the biggest or the best and tried to outdo the others with new acts.

One of the largest American circuses was Barnum's circus, started in 1871 by P. T. Barnum and two partners. In 1881, Barnum joined his show with James A. Bailey's circus. Beginning in 1888, it operated under the name of Barnum & Bailey's Greatest Show on Earth. In 1882, the five Ringling brothers started a variety show in Wisconsin, U.S.A. In 1884, they joined with Yankee Robinson to open their first circus. The Ringlings bought the Barnum and Bailey show in 1907. They joined the two circuses in 1919 to form the Ringling Brothers and Barnum & Bailey Combined Shows. This circus became the world's largest and most famous.

The first true circus in Australia was Radford's Royal Circus, established in 1847. The gold rushes in the 1850's gave circuses a ready audience and attracted touring American troupes. By the 1880's, Australia had its own circus families, such as the Ashtons, Perrys, Fitzgeralds, Wirths, and later the Bullens.

In the late 1900's, many circuses changed their emphasis from trained animals to human feats of skill and daring. This was partly because of the difficulty and ex-



Early circuses paraded through a town before the show began. This 1908 scene shows a crowd watching the animals and circus wagons pass by.

pense of finding suitable animals and keeping them in appropriate conditions, but also because, through television, many wild animals have become familiar in their natural surroundings. They are no longer seen as savage beasts that must be subdued.

Circus schools have long existed in Russia and China to train performers for their state circuses. Now circus schools have been started in many Western countries where students can learn juggling, clowning, acrobatics, and other circus skills.

Related articles in *World Book* include:

Barnum, P. T.	Lion (Training lions)
Buffalo Bill	Ringling brothers
Clown	Rome, Ancient (Recreation)
Hagenbeck, Carl	Stratton, Charles S.

Circus Maximus. See Hippodrome.

Cirque. See Glacier (How glaciers shape the land).

Cirrhosis is a condition of the liver in which scar tissue forms throughout the organ. Groups of cells called *regenerative nodules*, surrounded by sheets of scar tissue, replace the normal spongy tissue of the liver. The diseased organ may be unable to perform such vital functions as manufacturing proteins and removing harmful substances from the blood. The affected tissue may block the flow of blood, causing high pressure in blood vessels that serve the liver. Internal bleeding may then result. The blockage also may lead to the accumulation of fluids in the abdomen.

Many people with severe cirrhosis become weak and disoriented. Severe cases can cause death. But some cases do not even cause noticeable symptoms.

Cirrhosis results from damage to the liver. Excessive consumption of alcoholic beverages or *hepatitis* (inflammation of the liver) may cause such damage. Inhaling the fumes of certain chemicals, such as carbon tetrachloride, may also cause cirrhosis. After scar tissue forms, the liver cannot regain its sponginess. Some cases of cirrhosis can be controlled by proper diet and by avoiding alcohol.

Cirrus. See Cloud.

Ciskei was a *homeland*, an area set aside for the southern Xhosa people by the South African government (see **South African homelands**). Ciskei means *this side of the Kei*. It lay on the east coast between the Great Kei and Great Fish rivers, in what is now the Eastern Cape province. It occupied about 9,000 square kilometres. Bisho was the capital and seat of government.

The homeland had an official population of more than one million people. Many Ciskeians worked in other areas of South Africa. High population density, lack of mineral resources, and unemployment were major problems. Farmers in the homeland produced wool, raised livestock, and grew maize, sorghum, and wheat.

Farmers with a culture like that of the southern Xhosa people have lived in the area since the A.D. 1400's. The southern Xhosa chiefs date back to the 1600's.

The South African government recognized Ciskei as an independent republic in 1981. A new constitution in 1994 abolished the homelands.

Cistercians are monks and nuns who belong to two Roman Catholic religious orders throughout the world. Their daily routine follows a *rule* (set of guidelines) established by Saint Benedict of Nursia. This rule emphasizes prayer, study, and manual labour.

There are two orders of Cistercians—the Common Observance and the Strict Observance. Monks of the Common Observance sometimes teach and provide spiritual guidance in their communities. Nuns lead secluded, prayerful lives. The order of the Common Observance was formerly called the *Sacred Order of Cistercians*. Both monks and nuns in the Strict Observance lead secluded lives. The monks are popularly called *Trappists* and nuns, *Trappistines*. See **Trappists**.

Cistercian orders trace their history to a French monastery founded in 1098 at Cîteaux (Cistercium) by the abbot Saint Robert of Molesme. Orders of Cistercian nuns were founded about 1120.

Citibank is one of the largest banks in the world. It has more than 290 branches in the New York City metropolitan area and about 3,000 offices in 93 countries. The bank's history dates from June 16, 1812, when the New York state legislature granted a charter to the City Bank of New York. The bank entered the U.S. national system in 1865. The name of the bank was changed to Citibank in 1976. The bank is a subsidiary of Citicorp, a multinational financial services organization.

Cities. See City.

Cities of refuge were six cities of ancient Palestine. They were set apart as places of refuge for people who had killed other people either accidentally or in self-defence. They were Bezer, Ramoth-Gilead, and Golan, on the east side of the Jordan River, and Kedesh, Shechem, and Hebron on the west side of the river (Josh. 20). People who fled to one of these cities were protected from avengers until a trial could be held. If found not guilty of wilful murder, they were allowed to continue living in the city. If declared guilty, they were returned for punishment to the place from which they had fled.

Citizen King. See Louis Philippe.

Citizens' Advice Bureaux are offices in the United Kingdom that offer advice to the public on problems relating to citizens' rights and on the availability of social services. They also provide information on many other subjects. Voluntary workers run the bureaux in many towns and cities.

In the Republic of Ireland, Community Information Centres offer a similar service, informing the public of services provided by the government, local authorities, and voluntary organizations.

Citizens band radio is a method of short-distance communication used by private citizens. It operates on the *citizens band* (CB), a group of radio frequencies that many nations reserve for private use.

CB radio is most frequently used for conversations between places that are not linked by telephone. Many motorists and truck drivers use it to talk with other highway travellers or people who are in an office or at home.

Most CB sets are devices called *transceivers*, which consist of a transmitter and a receiver. Some CB devices receive radio signals but do not transmit them.

Most CB transmitters broadcast for distances of fewer than 8 kilometres in cities and up to 32 kilometres in rural areas. The broadcast range varies with the atmospheric conditions, the terrain, the design and height of the set's antenna, and the amount of power supplied to the transmitter. Government regulations limit the power of a CB transmitter.



Voting



Jury duty

Citizenship involves both rights and responsibilities. Citizens are guaranteed such privileges as the right to vote, the right of free speech, and freedom of religion. Citizens are also expected to obey laws, serve on juries, and perform other duties.

Citizenship is full membership of a nation or of some other unit of government. Citizenship is also called *nationality*. But nationality usually has a wider meaning and implies a right to protection by one's own country when visiting another country. Almost all people have citizenship of at least one country. Citizens have certain rights, such as the right to vote and the right to hold public office. They also have certain duties, such as the duty to pay taxes and to defend their country.

People who are neither citizens nor nationals of a country are *aliens* there. Most aliens are citizens or nationals of one country who are travelling or living in another. Many aliens have a permit called a *visa* allowing them to visit or live where they do not hold citizenship. *Illegal aliens* are noncitizens living in a country without proper papers.

The word *citizen* comes from the Latin word *civitas*, meaning *membership of a city*. Today, citizenship refers mainly to membership of a nation.

What it means to be a citizen

The rights of citizens differ from nation to nation. Many nations have constitutions that provide for basic

rights known as *civil rights*. They include freedom of speech, freedom of religion, and *freedom of assembly* (the right to gather peacefully for political or other purposes). Citizens of many countries have the right to vote for a government and the right to travel freely throughout their country. But in some countries these rights still do not exist.

The rights of citizens have some limits. In order to vote, a citizen must be registered and must have reached the minimum age. In many countries this age is 18. Freedom of speech does not allow a person to tell lies that damage a person's reputation.

The duties of citizens, like citizens' rights, differ from nation to nation. Most governments demand that citizens pay taxes, defend their country, and obey its laws. Some governments require certain citizens to serve on juries. In some countries, it is compulsory to vote in certain elections.

Many people believe that citizens also have duties not demanded by law, such as voting, even when it is not compulsory, learning about public problems, and protecting the environment in which they live. Many of these duties go along with rights. For example, the duty to vote comes with the right to vote. The duty to learn about public problems comes with freedom of speech and of the press, which protect the open discussion of public events and the exchange of ideas.

Aliens must obey the laws of the country in which they are travelling or living, except for those that bind only citizens. In addition, aliens must obey some of the laws of their homeland. For example, an alien working in a foreign country may still have to pay taxes to his or her own country as well as to the government of the country in which he or she is working. Travellers who break the laws of a country they are visiting may be put on trial and fined or imprisoned. Many nations grant *diplomatic immunity* to aliens who represent foreign governments. Diplomatic immunity is a set of special rights granted to the representatives of foreign governments and to the representatives' families and staffs. In many countries, these rights include freedom from arrest, search, and taxation.

Ways of becoming a citizen

Nations have various laws that govern the granting of citizenship. People become citizens in two ways: (1) by birth and (2) by naturalization.

Birth. Most people become citizens of a country simply by being born there. The right to citizenship in the country of one's birth is called *jus soli*, a Latin phrase that means *right of soil*. The laws of many nations grant citizenship based on *jus soli*. Some nations limit *jus soli* to children whose parents already have citizenship of that nation. Some nations also deny *jus soli* to certain groups of persons. Such persons include children who are born in a country where their parents are serving as diplomatic representatives. Persons denied *jus soli* also include babies born to *refugees* (persons who have been forced from their homeland by war or some other difficulty).

Some countries use another rule of citizenship instead of *jus soli*—or in addition to it. This rule provides that the citizenship of children is determined by the nationality of one or both of their parents, no matter where

the children are born. The right that a child has to citizenship in the country of its parents is called *jus sanguinis*. This legal phrase is a Latin term that means *right of blood*.

Naturalization is the legal process by which foreigners become citizens of a country they have adopted. Each nation sets requirements that aliens must meet to become naturalized. For example, they may be required to live in their new country for a number of years. Many nations naturalize only people who understand the rights and duties of citizenship and can use the national language. Some nations require aliens to give up citizenship in their homelands if they wish to become naturalized.

Dual citizenship

Some people hold citizenship of two nations. The condition of being a citizen of two nations is called *dual citizenship* or *dual nationality*.

Some people gain dual citizenship by birth. For example, a baby born to a French family visiting the United States would have U.S. citizenship by *jus soli*. The baby also would have French citizenship by *jus sanguinis*. People whose parents are citizens of two countries might have dual nationality by *jus sanguinis*.

Some people have dual citizenship as a result of naturalization. For example, a nation might allow its naturalized citizens to keep their original citizenship. Such persons could claim citizenship in two countries. Or, a nation might refuse to allow its people to give up their citizenship. People who declared that they no longer were citizens of such a country and became naturalized in another still would be claimed as citizens by the original nation.

Citizens of Commonwealth countries are all Commonwealth citizens and therefore are not aliens in any other Commonwealth country. However, they do not necessarily have citizenship of other individual Commonwealth countries. Although the Republic of Ireland is not part of the Commonwealth, under British law Irish citizens are not aliens.

The loss of citizenship

Expatriation is the act of giving up one's citizenship in a country. It also means the act of taking away a person's citizenship of a country.

Statelessness is the lack of citizenship in any country. Children of alien parents are born stateless if the country of their birth does not grant *jus soli* and the parents' homeland does not grant *jus sanguinis*. People can become stateless by giving up citizenship of one country without gaining citizenship of another.

Some people become stateless as a result of government action. For example, a government might punish citizens by expatriating them, leaving them stateless. In 1935, the German government led by the Nazi dictator Adolf Hitler expatriated all Jews living in Germany. Many other people become stateless when their homelands are destroyed by war.

History

The idea of citizenship developed in the cities of ancient Greece and Rome about 700 B.C. The early Greeks and Romans thought of cities mainly as communities,

rather than as geographic places. These communities consisted of citizens linked by such ties as friendship, family relationships, and participation in government. Not all the people had citizenship. For example, ancient Greek and Roman cities denied the right of citizenship to slaves.

The rights of Greek citizens included owning land and taking part in government. Their duties included voting, attending the government assembly, sitting on juries, and giving military service.

The special rights of Roman citizens included owning property, making contracts and wills, and suing for damages. As the Roman government expanded its rule, Roman citizens travelled to other lands to fight wars, rule territories, and conduct business. They kept all their special rights when they travelled anywhere in the Roman Empire. The government also began to grant Roman citizenship to people who had never lived in Rome. In A.D. 212, the government granted Roman citizenship to most people throughout the empire, except for slaves.

During the Middle Ages, which lasted from about the late 400's to about 1500, citizenship remained connected with cities. By this time, people thought of cities mainly as geographic places where people lived. During the 1500's and 1600's, nation-states developed. As a result, people began to think of citizenship as membership of a nation. The people of many of these nations gave their loyalty to a king or queen and were often called *subjects*.

During the 1700's, democracies began to develop. People living in democracies gave their loyalty to the nation instead of to the nation's ruler. As a result of this change in allegiance, the terms *citizen* and *national* began to replace *subject*.

Related articles in *World Book* include:

Bill of Rights	Nationalism
Civil rights	Nationality
Illegal alien	Patriotism
Immigration	Voting

Citlaltépetl. See Orizaba (mountain).

Citrangle is a hybrid plant derived from the sweet orange and the trifoliate orange. Although the fruit of the trifoliate orange is not eaten, the plants are hardier than ordinary oranges. Plant breeders developed the citrangle to be raised in Georgia and in other regions of the southern United States where the climate and soil do not allow oranges to grow. Commercial citrus plants



The citrangle looks and tastes like an orange.

have been grafted to the *rootstocks* (underground stems) of some types of citranges, especially Carrizo, Rusk, and Troyer varieties. The rootstocks provide a hardy, disease-resistant system for citrus plants. The citrange orange may grow from 5 to 8 centimetres in diameter. It has an acid, orangelike taste. The citrange is used in cooking and to flavour various kinds of beverages.

Citrate. See Citric acid.

Citric acid is a common organic acid that gives lemons, oranges, and other citrus fruits their sour taste. Lemon juice contains 6 to 7 per cent of the acid. The name *citric* comes from the Latin word *citrus*, which means *citron tree* (similar to lemon and lime trees). Carl Wilhelm Scheele, a Swedish chemist, first isolated citric acid from lemon juice in 1784.

Citric acid is used as a flavouring for soft drinks and pharmaceuticals. Industry uses it in chemicals, alkyd resins, and as a *mordant* (dye-fixative). It is also used to clean and polish steel, and to preserve colour and flavour in canned and frozen fruits and fish. Citric acid is prepared commercially from the fermentation of sugar, and by extraction from lemon juice, lime juice, and pineapple canning residues.

Pure citric acid forms colourless, odourless crystals that have a pleasant, sour taste. It is very soluble in water. Its chemical formula is $C_3H_4(OH)(COOH)_3$, and it melts at 153° C. Citric acid combines with metals to form salts called *citrates*.

See also **Acid**; Scheele, Carl Wilhelm.

Citrin is a chemical substance that belongs to a group of chemicals called *flavonoids*. Scientists do not know exactly what citrin is, or whether it is essential to the health of human beings. However, they have found that flavonoid substances help to control bleeding from the *capillaries* (the tiny blood vessels) in the body. Citrin, also called *vitamin P*, affects the capillary walls, making them less likely to haemorrhage. Citrin used in medicine is usually prepared by extracting it from paprika and lemon peel.

Citrine, Lord (1887-1983), a British trade union leader, was general secretary of the Trades Union Congress from 1926 to 1946. Walter MacLennan Citrine was born in Liverpool, England. He was president of the International Federation of Trade Unions from 1920 to 1943. After becoming a peer in 1946, he served on the Central Electricity Authority and the United Kingdom Atomic Energy Authority.

Citron is a large, usually sour fruit much like the lemon. It ranks among the largest citrus fruits. The citron tree grows wild in northeastern India. It is also grown commercially in Corsica, Greece, Israel, and southern Italy, and the fruit is exported to other countries. The thorny citron tree has leaves that range from 10 to 18 centimetres in length. The edges of the leaves are slightly toothed.

The fruit is 15 to 25 centimetres long, or longer, and shaped like an egg. It has a thick, firm *rind* (peel) that is preserved and candied for use in cakes, puddings, and candies. The rind also furnishes fragrant oils. The *etrog*, a variety of citron with small fruits, is grown for use in a Jewish ceremony called the Feast of the Tabernacles.

Scientific classification. The citron belongs to the rue family, Rutaceae. It is classified as *Citrus medica*.

Citronella is a pale yellow oil that is made from citronella grass. Citronella grass grows in China, Guatemala, Indonesia, Malaysia, Sri Lanka, Taiwan, and other countries. The oil of citronella grass contains citronellal and geraniol. These two substances have different boiling points, and they separate from citronella as the oil is distilled. Citronellal is used to make synthetic perfume ingredients. Geraniol smells like roses, and is used in the manufacture of many perfumes.

Citrus is the name of a group of trees and shrubs which belong to the rue family. Some citrus fruits are oranges; grapefruits; lemons; mandarins, including clementines, satsumas, tangelos, tangerines, tangors, and their hybrids; kumquats; bitter oranges; limes; citrons; pomelos; and bergamots. Citrus trees grow wild in parts of India and southeastern Asia. The Chinese were the first to cultivate citrus trees, more than 4,000 years ago. These trees and shrubs have been grown in other parts of the world for their fruits for many years.

Citrus trees are thorny, but usually attractive. They are evergreen, with long, shiny, pointed leaves. The flowers are fragrant. Ripe citrus fruits may be green or yellow to orange-red in colour. All citrus fruits are a type of berry that scientists call a *hesperidium*.

Citrus fruits all grow in rather warm climates. They grow best where there is almost no frost or wind. All grow in tropical regions, but produce better fruit in a slightly cooler climate. Citrus fruits are valuable foods. They contain large amounts of vitamins and minerals. Citrus fruits are usually high in vitamin C, which humans need daily if they are to stay healthy.

Scientific classification. Citrus plants are members of the rue family, Rutaceae. This family consists of six genera: *Fortunella*, *Eremocitrus*, *Poncirus*, *Clymenia*, *Microcitrus*, and *Citrus*.

Related articles in World Book include:

Bergamot	Lime
Citron	Orange
Grapefruit	Tangelo
Kumquat	Tangerine
Lemon	Tangor



The citron is a citrus fruit that resembles a large lemon. A citron is shaped like an egg and has a thick, firm pale yellow rind. The fruit grows on the small, thorny citron tree.



Crowded street scenes—like this one in Lima, Peru—are common in cities throughout the world. Cities occupy only a small portion of the world's land. But more than 40 per cent of all people now live in or near cities, and the percentage continues to grow.

City

City is a community where thousands—or even millions—of people live and work. Cities are the world's most crowded places. New York City, for example, has an average of about 7,490 people per square kilometre. The United States as a whole averages only 26 people per square kilometre. Similarly, other large cities of the world have population densities hundreds or thousands of times as large as the average national population densities.

Most cities are overcrowded, dirty, and noisy—and sometimes unpeaceful. Traffic jams delay people who are trying to get to and from work, shops, or other places. Aeroplanes, cars, buses, trucks, electric power stations, factories, and other sources pollute the air with fumes that endanger people's health. Motor vehicles, factories, sirens, and building and demolition machinery create noise that often becomes nerve-racking. Many cities have a high crime rate, and violence sometimes breaks out between racial, religious, and other groups. City people have also rioted to protest about poor housing and other undesirable living conditions.

But despite all the drawbacks, the percentage of the world's people who live in *urban places* (cities and their surrounding areas) keeps growing. In 1800, only about 2½ per cent of the world population lived in urban places. This figure had jumped to about 40 per cent by 1980 and is expected to reach about 50 per cent by the year 2000.

People choose to live in or near cities for several rea-

sons. The main reason is the number and variety of jobs available. The economies of such nations as Canada, France, Germany, Japan, the United Kingdom, and the United States are based chiefly on manufacturing. Most manufacturing takes place in and near cities, and so most of the jobs are there. Far fewer jobs are available in the cities of developing nations, including most of the countries of Africa, Asia, and Latin America. Even so, large numbers of people flock to these cities. Many are farmers who can no longer earn a living from the land. They go to cities in search of jobs, but many are not able to find work.

Cities also offer many cultural and recreational activities. City residents need not travel far to go to art galleries, museums, and concerts. They can shop in nearby stores that sell thousands of products and can borrow books from huge public libraries. They can also conveniently attend films, plays, and sports events.

Many people choose to live in or near a city simply because they like the rapid pace of city life. Perhaps these same people complain bitterly about the crowds, dirt, and noise in a city. But they like the bustling activity that makes city life so different from rural life.

There is no standard that tells how many people a community must have to be classified as a city. In fact, some communities are called cities for reasons that have nothing to do with their population. In the United States, for example, one definition of *city* is any community—regardless of population—that has some form



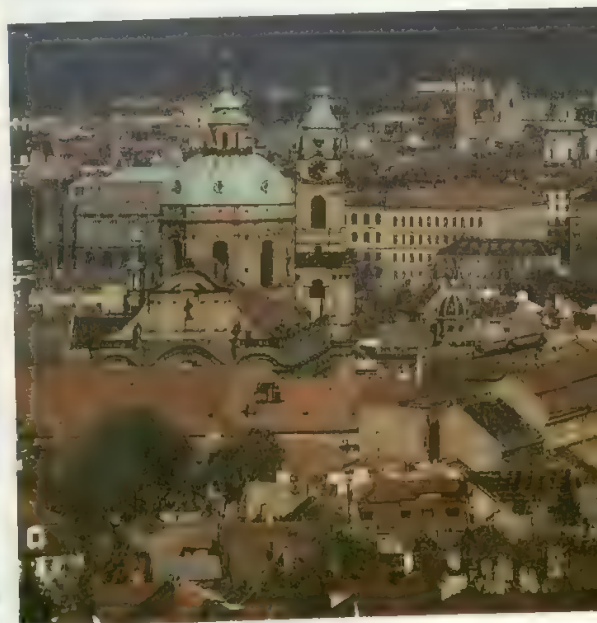
The business centre of a city is packed with tall buildings where people work and shop. In Lagos, Nigeria, *above*, and other cities, residential areas stretch beyond the centre.



Trade and industry provide jobs for millions of city dwellers. An open-air grain market in Kabul, Afghanistan, *above*, helps make that city an important trading centre.



Leisure activities are an important aspect of city life. Sailing is a popular recreation in many coastal cities, such as Sydney, *above*.



The historic centre of a city can sometimes be several hundred years old. The Old Town of Prague, in the Czech Republic, *above*, dates from the 1300's.

Comparing the sizes of cities

A city determines its population by counting the people who live within its political boundaries. But cities of the world define their city limits differently, making population comparisons difficult. In some countries, city limits are fixed so that they do not overlap or include other cities and towns. In other countries, cities include other urban and rural areas.

Countries also determine metropolitan areas in various ways. In some countries, metropolitan area boundaries follow county lines. Each metropolitan area includes a county with a large city and perhaps nearby counties. But in many other countries, a metropolitan area does not have definite political boundaries. Instead, metropolitan areas include the major city and urban

and rural areas that are socially or economically identified with it. São Paulo has the largest population of any city in the world as well as the largest metropolitan area population.

Some governments do not report separate city and metropolitan area populations in their censuses and population estimates. In such cases, the same city proper figure appears in both the cities and the metropolitan areas tables, *below*, to show the existence of a metropolitan area.

The table, *bottom*, shows the populations of cities on each continent that are identified as centres of cultural, social, or political significance.

Largest cities in the world

Baghdad	5,908,000	Mexico City	8,235,744
Bangkok	5,760,000	Moscow	8,801,000
Beijing	7,760,000	New York	
Bombay	9,925,891	City	7,322,564
Cairo	6,052,896	Rio de Janeiro	5,093,232
Calcutta	4,899,819	St. Petersburg	4,295,000
Delhi	7,562,200	São Paulo	11,128,848
Hong Kong	5,756,000	Seoul	9,645,932
Istanbul	5,475,982	Shanghai	8,214,436
Jakarta	6,761,886	Teheran	5,734,199
Karachi	5,208,170	Tianjin	5,300,000
Lima	5,493,900	Tokyo	8,163,573
London	6,378,600		

Largest metropolitan areas in the world

Baghdad	5,908,000	Manila	7,561,413
Beijing	10,819,407	Mexico City	15,047,685
Bombay	12,571,720	Moscow	8,967,000
Buenos Aires	10,934,729	New York City	8,546,846
Cairo	10,000,000	Paris	9,060,257
Calcutta	10,916,272	Rio de Janeiro	9,018,647
Chicago	6,060,387	São Paulo	17,112,712
Delhi	8,375,188	Seoul	9,645,932
Hong Kong	5,756,000	Shanghai	13,341,896
Jakarta	6,761,886	Tianjin	7,990,000
Lima	6,053,900	Tokyo	11,618,281
London	6,378,600		
Los Angeles-Long Beach ...	8,863,164		

Major cities of each continent

Africa		Asia		Europe		North America	
Abidjan	1,850,000	Baghdad	5,908,000	Athens	748,110	Havana	1,924,886
Cairo	6,052,896	Beijing	5,760,000	Berlin	3,062,979	Los Angeles	3,485,398
Cape Town	789,580	Bombay	9,925,891	Brussels	1,377,338	Mexico City	8,235,744
Casablanca	2,139,204	Hong Kong	5,756,000	Budapest	2,075,990	Montreal	1,015,420
Kinshasha	2,222,981	Jakarta	6,761,886	Dublin	477,675	New York City	7,322,564
Australasia		Kuala Lumpur ...	1,145,075	Istanbul	5,475,982	South America	
Auckland	855,571	Manila	1,598,918	Kiev	2,409,000	Bogotá	3,982,941
Canberra	247,194	Seoul	9,645,932	London	6,378,600	Buenos Aires	2,965,403
Melbourne	3,022,157	Shanghai	8,214,436	Madrid	2,909,792	Lima	5,493,900
Sydney	3,538,970	Singapore	2,308,200	Moscow	8,275,000	Rio de Janeiro	5,093,232
Wellington	325,682	Teheran	5,734,199	Paris	2,176,243	São Paulo	11,128,848
		Tokyo	8,163,573	Rome	2,775,250		

Sources: 1976-1995 censuses and estimates



The largest cities in the world, such as São Paulo, *above*, have populations of over 9 million.

of city government. But most people use the word for large urban communities. This article uses the word *city* in that sense.

There are population standards for distinguishing urban places and rural places. The standard for distinguishing urban and rural places varies among the nations of the world, ranging in population size from

about 2,500 to 10,000 people. The United Nations considers as urban only those communities that have a population of 20,000 or more.

This article tells how cities began and developed. It describes cities and city life throughout history. It also discusses the problems of today's cities and takes a look at cities of the future.

How cities began and developed

Human beings have probably lived on the earth for about 2 million years. But they began to live in permanent settlements only about 10,000 years ago. Men and women who established these settlements are called New Stone Age, or *Neolithic*, people. Before people began living in permanent settlements, they wandered from place to place to hunt animals and gather plants for food. Neolithic people were the first farmers. As farmers, they no longer had to wander to find food, and they began to settle in villages.

By about 3500 B.C., a number of Neolithic villages had developed into small cities. Ever since the first city appeared, many peoples have founded many cities in many places—and for many reasons. These cities have differed in size and layout, and they have had a variety of economic, governmental, and social systems. But all permanent settlements—from Neolithic village to giant city—needed four main features to begin and to grow. These features were (1) advances in technology, (2) a favourable physical environment, (3) social organization, and (4) population growth.

Advances in technology. The word *technology* refers to the discoveries and inventions that help people change and improve their way of life. The development of farming skills was the technological advance that led to the founding of cities.

Neolithic people learned how to grow crops and invented tools that improved farming methods. They also domesticated animals, which they used to do work and as a source of food. All these developments helped many Neolithic families produce more food than they needed.

Because of this surplus food, a number of people switched to jobs other than farming. Some became skilled at crafts and made baskets, cloth, leather goods, tools, or other products. Others became miners and dug for flint, metal, and stone. The nonfarmworkers got their food by trading the things they made to the farmers for surplus crops. Through the years, technological advances in agriculture enabled more people to become nonfarmworkers. These people founded and populated the cities of the world.

Technological advances have influenced city life throughout history. For example, the development of the steam engine in the 1700's gave people the power source they needed for large-scale manufacturing. Many cities became giant manufacturing centres partly because of this development. Sometimes industrial expansion led to the construction of new cities. During the 1900's, thousands of suburbs grew up around big cities. The car and the railway train—two technological advances in transportation—helped make these suburbs



Neolithic villages were the ancestors of cities. An artist's conception, right, shows how the Neolithic village of Jarlshof in the Shetland Islands may have looked. A wall surrounded the houses and a tall watchtower. Many people stored food in large jars. A painted storage jar, above, was found in Pakistan's Indus Valley. It stands about 75 centimetres high.



possible. Many people who lived in the suburbs needed cars and trains to get to and from work in the cities.

Physical environment of a city includes its location and climate and the availability of water and food. Cities have been founded in many kinds of environments, but their development has depended on certain favourable environmental features. All cities must have enough drinking water. Early communities, which depended on farming, needed enough rainfall to grow crops. Good soil was also essential for growing crops, and nearness to other food—animals and edible plants—was helpful. Other environmental features favourable to the development of cities included a reasonably mild climate and a location near materials that could be used for clothing and shelter.

Early peoples found many favourable environmental features in river valleys in subtropical climates. Some of the earliest villages and cities lay in the Tigris-Euphrates Valley in the Middle East, the Nile Valley in Egypt, the Huang He (Yellow River) Valley in China, and the Indus Valley in India and Pakistan. See *World, History of the* (Early centres of civilization).

Through the years, other environmental features have also helped cities develop. Since ancient times, for example, people have travelled in ships to trade with people of other nations. Many cities that lay near large bodies of water became important trading centres. They included Istanbul, Turkey; London, England; Shanghai, China; and Venice, Italy. Chicago, in the United States, and Toronto, in Canada, developed partly because they lay along important land and water transportation routes. Many cities, including Manchester, England, gained importance as manufacturing centres because of nearby minerals or other raw materials needed for manufacturing. Some cities owe their development chiefly to climate. The warm, healthy climate of parts of Florida and the southwestern United States attracted many people.

Social organization. Certain rules of behaviour are needed to maintain order, peace, and security in any community. Since Neolithic times, most people have agreed that it is wrong to harm or steal from others in their group. In turn, people expect that their own rights to safety and property will be respected by other members of the group. People also have duties toward their

group as a whole. They have often fought to protect their group from enemies.

The maintenance of order in groups also requires some system of authority. In the family, the most basic social group, parents have authority over their children. In larger social groups, including cities, citizens must accept the authority of government.

Neolithic villages had a simple social organization. People were required to respect each other's rights, and children had to obey their parents. But most villages had few government officials as we think of such officials today. Someone probably took care of the surplus food, and there may have been a chief planner for defence against outsiders. As cities grew, the duties of family members and neighbours toward each other remained basically the same. But to keep order in cities, governments took on a greater role in managing community affairs and providing services for the people. The number of government officials and workers required by cities also increased greatly. Today, many cities need thousands of government workers. These workers include mayors, city planners, clerical employees, fire fighters, rubbish collectors, health officials, police officers, and teachers.

Population growth. Only about 10 million people existed during the Neolithic Period. The population of the world reached about 500 million by A.D. 1650 and about 4½ billion by 1980. This *population explosion* led to an increase in both the size and number of cities.

Two other trends also have aided the development of cities. One trend—sometimes called the *population implosion* or *population urbanization*—is the ever-increasing concentration of people in small parts of the earth. These parts are the cities and their surrounding areas. The other trend—sometimes called the *population dispersion* or *population diversification*—is the movement to cities by people of a variety of cultural backgrounds.

Through the years, cities came to include people of different racial, religious, national, and language groups. This mixing of people brought about *cultural diffusion*, a process by which people of different backgrounds learn from each other by exchanging ideas. Cultural diffusion ranks among the most important factors in the development of civilization.

Ancient cities

Hundreds of years passed before the Neolithic villages developed into cities. The first cities appeared about 3500 B.C. in the Tigris-Euphrates Valley of Sumer. This valley lay in the lower part of Mesopotamia, in what is now Iraq. Egyptian villages in the Nile Valley developed into cities about 3000 B.C., and villages in the Indus Valley became cities about 2500 B.C. The first Chinese cities probably began to appear about the mid-1600's B.C. Indian villages in Central America developed into the first cities of the Western Hemisphere about 200 B.C.

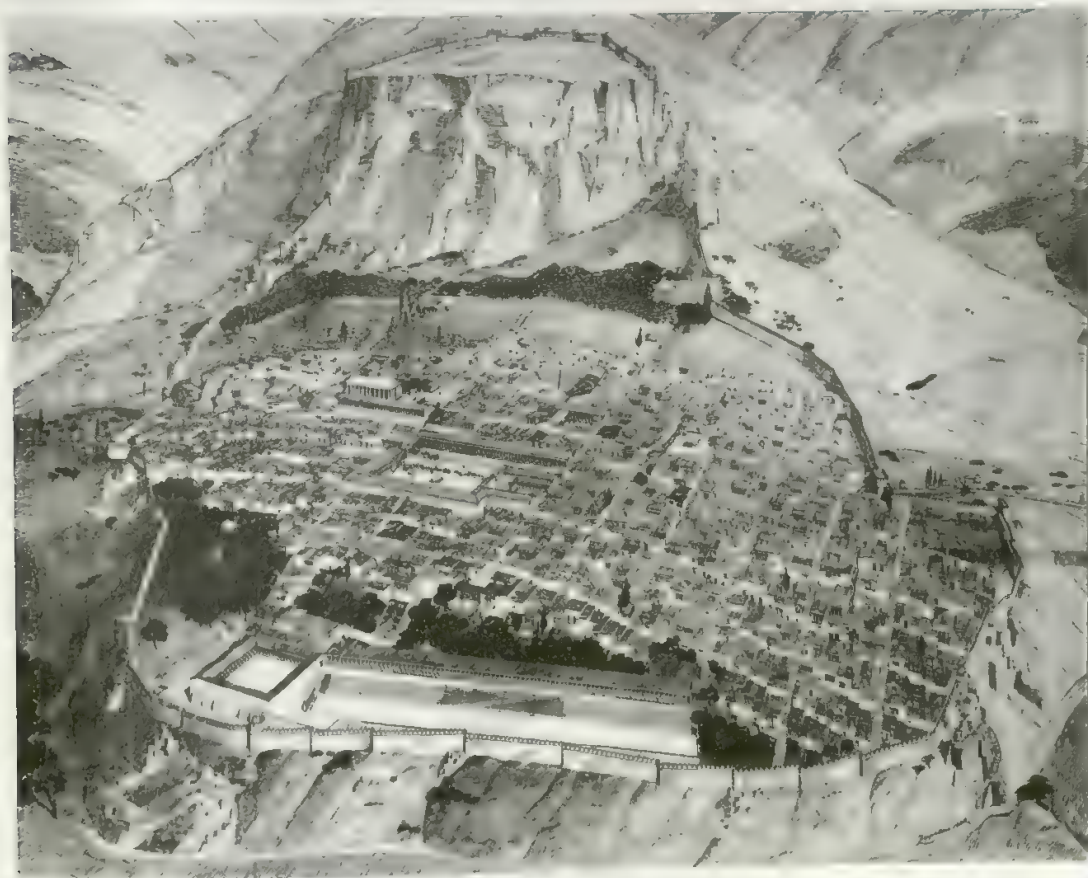
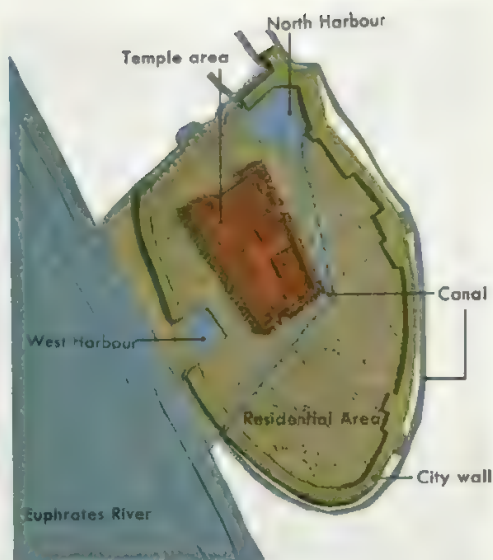
Ancient cities differed from Neolithic villages in several ways. The cities were bigger than the villages and they had large public buildings, including temples for worship and places for storing grain and weapons.

The cities had more people than the villages and, unlike the villages, they attracted people from a variety of backgrounds. The work of the city people also differed from the work of the village people. Almost all village workers were farmers. Some city people farmed land outside the cities, but most of them had jobs that had nothing to do with farming. Craftworkers and government workers became numerous in the early cities, and a new group of workers—the *merchants* and *traders*—appeared.

Description. An early ancient city covered less than 2.5 square kilometres. Most of its people lived near the city's water supply because they had to get their own water and carry it home themselves. Technological advances—including the construction of aqueducts for



Ur was one of the first cities. The Sumerians founded it about 3500 B.C. in what is now Iraq. They built a *ziggurat* (temple), *background above*, in the shape of a mountain—perhaps because they once worshipped on mountaintops. The plan of Ur is shown on the right.



Priene, an ancient Greek city, lay in what is now western Turkey. The wall around the city helped keep invaders out. The market place, consisting of long, narrow buildings and a large yard, dominated the centre of Priene. Government buildings, houses of worship, and an outdoor theatre stood nearby. A huge gymnasium and a stadium stood along the near wall. The houses in many cities today, were laid out in rectangular blocks.

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Rome, one of the largest ancient cities, reached a size of more than 10 square kilometres and a population of nearly a million. Aqueducts carried water from mountain springs. One of these long wall-like structures appears at the lower right of the model of Rome above. Rome had huge public buildings. These included the oblong Circus Maximus, *left*, and the circular Colosseum, *right*, where people were entertained, and many government buildings.

transporting water long distances—enabled some ancient cities to grow. For example, Rome grew to a size of more than 10 square kilometres after the city developed an outstanding system of aqueducts.

Many ancient cities had walls surrounding them for protection against enemies. Hills also helped protect some ancient cities. Rome lay on hills, and Athens was built around a hill where the people could go in case the city was attacked by enemies.

The central area of most cities included a place of worship, the ruler's palace, and a storehouse for food. In some cities, this central area was surrounded by a wall that had been built to keep out both enemies and hungry citizens. Houses stood crowded together around the central area.

Sanitation presented a major problem in ancient cities, most of which had no system for getting rid of wastes. The people simply threw rubbish and other wastes into the streets or piled them up outside the city wall. As a result, disease spread quickly and death rates were high. The narrow, unpaved streets often turned into seas of mud when rain fell.

Some ancient cities reached a more advanced degree of development. Rome, for example, had a sewer system, a water supply system, and many huge public structures, including public bathhouses. Other advanced ancient cities included Athens, Babylon, and the great cities of Egypt. See Athens; Babylon; Egypt.

ancient; Jerusalem (illustration: Jerusalem at the time of Jesus Christ); **Rome** (The ancient city).

The people. Ancient cities had more people than did Neolithic villages, but far fewer than cities of today. Most of the cities had populations of under 10,000, though Athens, Beijing, Rome, and many other cities were much larger.

The first peoples of the first cities formed *homogeneous societies*. That is, they had the same racial and geographic backgrounds and shared the same religious beliefs and other cultural characteristics. But the cities soon began to draw people from a variety of backgrounds. Many people moved from the countryside in search of a better life in a city. Others had been captured in war and were brought to cities to serve as slaves. The arrival of newcomers gave the cities *heterogeneous societies*, made up of people of many different backgrounds.

The formation of heterogeneous societies caused cultural diffusion, but it also had undesirable effects. In many cities, the original group and the newcomers distrusted each other. Various forms of prejudice and discrimination developed.

The people of ancient cities were divided into classes. The upper class included rulers, government and military officials, and high priests. The lower class consisted of farmers, craft workers, and merchants. At the very bottom of society were the newcomers, especially

slaves and people from greatly different backgrounds than those of the native citizens. The newcomers were called *outcasts*, and most of them were forced to live in separate sections of the cities. The outcasts had the poorest housing in the city, little food and clothing, and no education.

Upper-class families lived in large houses. Most other people lived in small one- or two-room houses. In many families of all classes, children, parents, grandparents, and other relatives lived in the same house.

In most ancient cities, only boys from upper-class families received a formal education. Boys from other classes learned a craftworker's trade—usually that of their father—or received no education at all. Girls of all classes learned various household duties from their mothers.

Most people worshipped a number of gods. Many thought that angry gods caused personal misfortune. Festivals were held to honour and to please the gods. Many ancient peoples, including the Egyptians, Greeks, and Romans, built beautiful temples and monuments and dedicated them to the gods. Some Indians of Central and South America also followed this practice. For example, ancient Indians constructed the famous religious buildings at Teotihuacán, near Mexico City.

Economy. Just as technological progress in agriculture had made Neolithic villages possible, further advances in farming spurred the development of ancient cities. The invention of new farm tools and the discovery of new methods of cultivation, irrigation, and animal

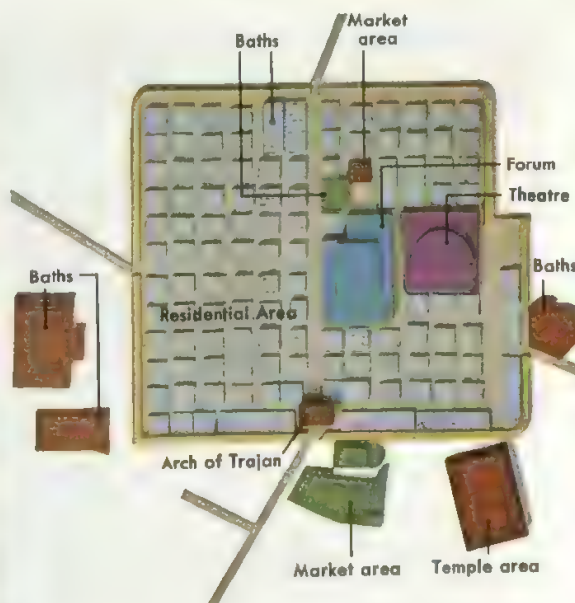
rearing helped increase food surpluses. As the surpluses increased, more and more people stopped farming and went to cities in search of other work.

Craftworkers became an important group in the cities. The first craftworkers wandered from place to place because no one community had enough work for them. But as cities grew large enough to support them, craftworkers began settling permanently.

The first craftworkers sold the products they made. Later, city life grew more complex and a new group of working people, the merchants, appeared. This group sold the products made by others.

The merchant class was a result of technological advances in transportation. The wheel, invented in the Tigris-Euphrates Valley about 3000 B.C., gradually came into general use during ancient times. Wheeled vehicles and vastly improved roads allowed people to move large amounts of goods within cities and from city to city to be traded. Improvements in water transportation enabled merchants to trade their goods both in nearby places and in distant lands. Foreign trade became important to the economy of some ancient cities. The Phoenicians played a leading part in the development of trade over large bodies of water.

Government. Religious leaders performed most duties of government in the earliest communities. The people believed that their leaders' authority came from the gods. Therefore, the leaders were responsible to the gods, not to the people. As communities developed, emperors, kings, and other nonreligious rulers took



Timgad, part of the giant Roman Empire, was built about A.D. 100 in what is now Algeria. Military engineers planned Timgad and many other cities in the empire as camps for Roman soldiers. The ruins of Timgad, *left*, and a plan of the city, *above*, show the orderly arrangement of buildings and streets that was typical of the work of these military men.

over the power to govern. These rulers developed laws that could be enforced by military and police power. But many people still believed that the right to govern came from the gods. As a result, rulers had both the divine right to rule and the civil power to enforce laws.

Local administrators governed most ancient cities. They were responsible to the emperor, the king, or some other higher authority. Some cities, including Athens, were independent of any higher authority. Their rulers governed the city and its outlying area.

Such regions were called *city-states* (see *City-state*).

The upper class ran the governments of ancient cities. They taxed the craftworkers, farmers, and merchants heavily to pay the costs of operating the government, constructing public buildings, and carrying out other projects. The people had little or no voice in the government. Athens and some other Greek city-states were important exceptions. In those communities, all adult males who were not slaves helped decide government policy. See *Democracy* (Origins of democracy).

Medieval cities

The Middle Ages began after the fall of the Roman Empire in A.D. 476 and lasted until the 1500's. The Roman Empire ruled a vast region that, at its height, included most of Europe, the Middle East, and the northern coastal area of Africa. Rome was its capital.

The Romans helped build cities throughout their empire. They also built a network of roads that served as trade routes between the cities. The empire declined during the 400's, and Germanic tribes conquered it and divided it into many kingdoms. These tribespeople were warriors, hunters, and farmers who had little interest in trade. After the fall of the Roman Empire, trade among European cities almost stopped. Thousands of people left the cities and went to work on farms. Between the 400's and 1000's, the populations of existing cities decreased and few new cities appeared. Trade regained importance after about 1000, and cities began to grow again.

Description. Many European medieval cities had a

similar layout. A typical city covered less than 2.5 square kilometres and had walls around it for protection against invaders. The city's main church—in many cases a magnificent, towering Gothic cathedral—stood in the central area. The church was the city's biggest and most expensive building and a symbol of medieval emphasis on religion. The chief government buildings and the market place were near the church. Wealthy people lived near the centre of the city and the poor lived away from this area. Some poor people even lived in huts outside the walls.

Some medieval cities, like ancient cities, were dirty and unhealthy. Disease spread rapidly, partly because the people had no sanitary method for getting rid of rubbish and other wastes. From time to time, disease wiped out a large part of a city's population.

The walls around medieval cities limited the amount of living space. Land was expensive, so people began putting up five- and six-storey buildings. Overcrowding



Medieval Europe had many small, walled cities. Magnificent churches rose above the other buildings, symbolizing medieval society's emphasis on religion. The Cathedral of Notre Dame in Reims, France—marked "A" above—was one of the biggest, most beautiful medieval buildings.

Etching (1600's) by an unknown artist. Bibliothèque Nationale, Paris



Illustration from an illuminated manuscript (1500s) by an unknown Flemish artist

Cities in Flanders—including Bruges, *left*, and Ghent, Liège, and Ypres—grew prosperous from trade during the Middle Ages. Flemish merchants shipped large quantities of wool across the North Sea to England. They also carried on a heavy overland trade in France, Germany, and other countries. Flanders was sometimes called the market place of Europe.



Engraving from *L'Ambassade de la Campagne Orientale* by Pierre de Coyer and Jacob de Keyser

Many Eastern cities prospered, even while European cities were struggling to survive in the early Middle Ages. Guangzhou (also called Canton), China, *above*, was among the busiest medieval trading centres. It became one of the first Eastern cities to trade with the West.

became a problem during the late Middle Ages. Some cities solved this problem by knocking down the walls and rebuilding them farther out. Florence, in Italy, increased its size three times in this way. Other cities let their walls stand but built new cities nearby.

Scholars believe that Eastern medieval cities had the same general pattern as European cities. But Eastern trade did not decline, and many Eastern cities continued to be large and prosperous throughout the Middle Ages.

The people. Many medieval communities were small settlements with only 300 or 400 people. Even Lübeck, Germany, an important city in northern Europe, had a population of only about 10,000 during the 1200's. In that same period, London, with about 40,000 people, Venice, with about 100,000, and Paris, with about 150,000, ranked among the biggest cities in Europe. Many Oriental cities probably had more people.

European medieval cities attracted people from a variety of backgrounds. But the people tended to settle in *quarters* (neighbourhoods) with people of their own group. Some quarters resembled separate cities. They had their own markets, churches, water supplies, and other facilities. People almost always stayed in their own neighbourhoods. The system of separate quarters helped limit conflicts between the people of the various groups, but it also limited the exchange of ideas.

Upper-class medieval people lived in large houses that had separate rooms for bathing, cooking, eating, sleeping, and religious and social activities. The idea of different rooms for different activities also began to appear among the middle and lower classes. But most of these people continued to live in apartments or houses with one or two rooms that were used for all purposes. Some public institutions developed that gave the people the benefits of specialized use of space. These institutions included public bakeries, bathhouses, and hospitals. But few people in a medieval city had much comfort or privacy.

During the Middle Ages, children, parents, grandparents, and other relatives continued to live in the same house. Some medieval households also included servants and workers associated with the family's economic activity. For example, some young men of the upper class worked as personal servants to noblemen and lived in the noblemen's houses. Many *apprentices* (young people learning a craft) lived in the homes of the skilled workers who taught them.

As in ancient times, formal education was largely restricted to boys of the upper class. In Europe, the Christian church played an important part in medieval education and ran most of the schools. Priests taught in these schools and also in many schools that were run by governments.

Illustration from an illuminated Latin manuscript by an unknown artist (1300s)

Trade fairs were held each year in many European cities during the Middle Ages. Merchants travelled from fair to fair, buying and selling goods and exchanging ideas about new products and production methods. In the scene on the right, a bishop blesses a trade fair while merchants discuss prices and a man on horseback prepares to amuse fairgoers with acrobatic tricks. Trade fairs became part of the general revival of trade that spread through Europe after about 1000. This revival helped cities prosper and grow. Most European cities had lost importance and stopped growing after the Roman Empire fell and trade almost stopped in the late 400s.



Religion played a vital role in medieval life. Major religions included Christianity in Europe, Islam in the Middle East, and Buddhism and Hinduism in the East.

In Europe, the Christian church had great influence. Church officials owned much land and could tax the people. The church also performed such important activities as baptism, marriage, and burial services. The church could ban people from religious services through its power of *excommunication*. An excommunicated person was a public disgrace. In addition, people who did not belong to the Christian church were often treated harshly. For example, Jews in the Christian cities of medieval Europe suffered much persecution.

Economy. During the Middle Ages, much land in Europe was divided into large rural estates called *manors*. Lords and bishops owned most of the land, and peasants farmed it for them. This economic system, called *manorialism*, began to decline during the 1000's. Many peasants began moving to cities to earn a living. Some became merchants or craftworkers. Others farmed land outside the cities and helped supply food for the city dwellers.

The growth of trade played the leading part in the economic progress of medieval cities. Trade had declined after the fall of the Roman Empire. But Venice, an Italian city, traded with Constantinople (now Istanbul), Turkey, throughout the Middle Ages. Venice remained prosperous even after other European cities declined. After those cities began to grow again, Venice traded with them. The cities grew and prospered and traded with each other. The increased trade brought further growth and prosperity to European cities.

Cities that played an especially important part in the economic revival included Antwerp in Belgium; Bruges in Flanders; Nantes, Orléans, Paris, and Rouen in France; Cologne, Hamburg, and Lübeck in Germany; and Genoa and Pisa, in addition to Venice, in Italy. Oriental trading centres included the Chinese cities of Guangzhou (also called Canton), Hangzhou (also spelled Hang-chou), Kaifeng, Beijing, and Suzhou (Su-chou).

Technological advances also aided the economic progress of medieval cities. New products included barrels and tubs, gunpowder, mechanical clocks, paper, printing presses, and soap. The use of water and wind power to make products increased production, thus raising standards of living and stimulating city growth. The invention of the printing press enabled people to get information about business and government more quickly than ever before. Newspapers and printed books increased the exchange of ideas among people.

Craftworkers and merchants benefited greatly from

the economic progress. Because of the expanding trade and new inventions, craftworkers could make more goods and merchants could sell more. The new prosperity drew even more people to the cities, providing additional markets for the craftworkers and merchants.

The craftworkers and merchants formed a new economic class—the *middle class*. To ensure their continued prosperity, they formed organizations of workers called *guilds*. There were guilds for merchants and craft guilds for bakers, brewers, goldsmiths, tailors, weavers, and other workers. By banding together, the guild members increased their profits. In groups, they could buy large quantities of materials and goods at low prices. The guilds allowed only their members to make and sell products. They kept their memberships from growing too large so that each member could prosper. See *Guild*.

Government. A system of government called *feudalism* developed in Europe during the Middle Ages. The feudal system divided kingdoms into sections called *fiefs*, each ruled by a lord or bishop. Feudalism weakened the power of kings because a king ruled only the land he owned, rather than an entire kingdom. Cities were governed by the lord or bishop who owned the land on which they stood. See *Feudalism*.

As cities gained importance during the 1000's and 1100's, many city people began to resent the interference of lords and bishops in local affairs. Led by the merchant and craft guilds, citizens fought for the right to govern themselves.

Many cities succeeded in their struggle for self-government. In Milan and other Italian cities, the people won the right to elect *consuls* (officials who ran the city government). The practice of electing consuls then spread to other parts of Europe. Cities in Flanders and northern France achieved a high degree of independence. The people made their own laws and elected their own officials. Guild members ran many of the cities. Some kings supported the people in their fight for self-government because strong city governments weakened the power of the lords and bishops.

During the 1400's and 1500's, many kings gained power over large regions. They set up strong central governments, which reduced the power of cities.

In the East, government remained centralized throughout the Middle Ages. The king or emperor appointed local officials, but he took steps to name capable individuals. In China, a candidate for office had to pass a civil-service examination. After being appointed, officials were watched over by government inspectors.

Industrial cities

For about 300 years after the Middle Ages, cities throughout the world grew and gradually changed. But the basic pattern of cities and city life remained much the same. During the 1700's and early 1800's, the period of the *Industrial Revolution*, many cities in Europe and North America changed greatly. These communities—called *industrial cities*—became centres of large-scale manufacturing. The manufacturing boom resulted chiefly from the invention of machines that did the work

of many people, and of the steam engine, which powered the machines.

Life in industrial cities centred around factories, where the manufacturing took place. Most of the people in these cities worked in the factories, lived near them, and depended on them completely for their livelihood. Living conditions in industrial cities improved gradually during the 1800's and early 1900's. However, when the Industrial Revolution began, most of the people were

overworked, underfed, poorly housed, and exposed to the danger of death from disease. See **Industrial Revolution**.

The Industrial Revolution had little immediate effect on cities outside Europe and North America. Some cities of Africa, Asia, Australia, and South America became industrial centres in the late 1800's and the 1900's. Others never became industrialized.

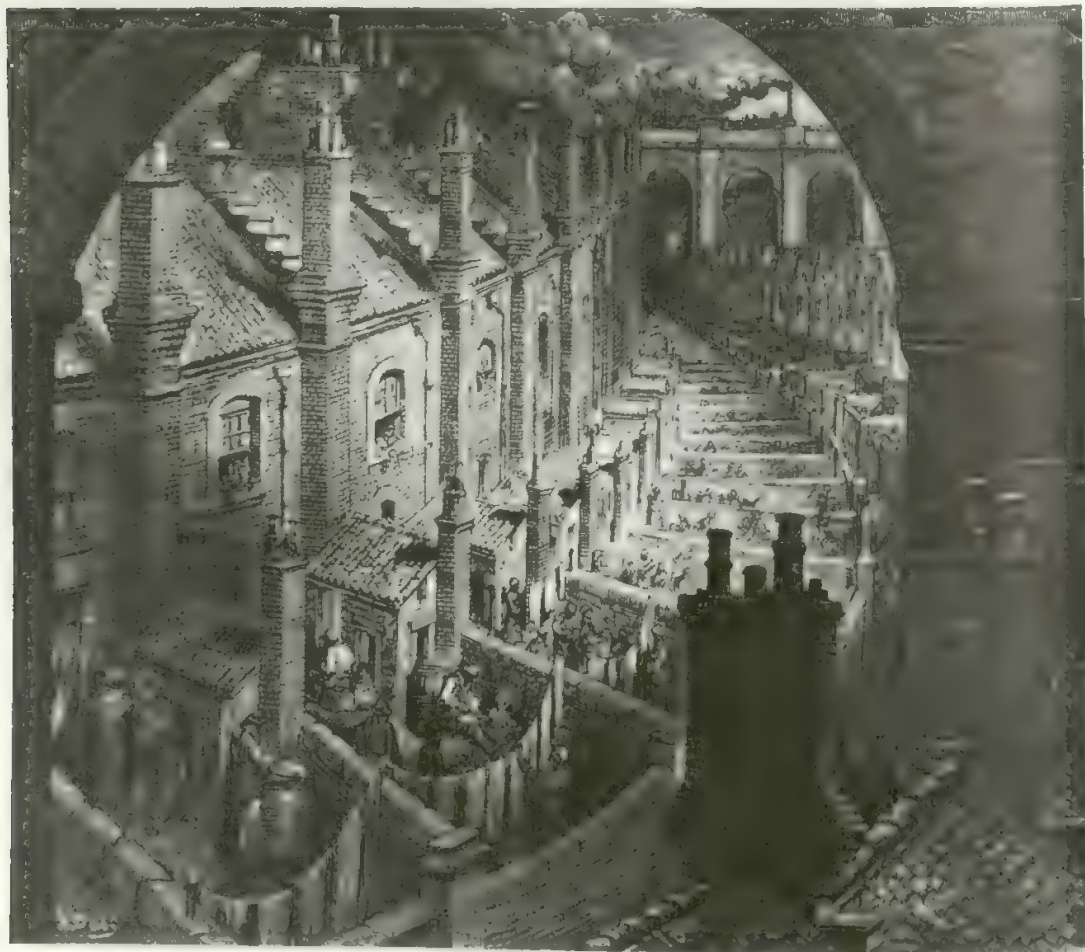
Description. Some industrial cities developed from medieval cities. When a city became too crowded, the walls were knocked down and the city was expanded. Other industrial cities grew up where there had been a fort, a trading post, a village, or open land. Development in open areas occurred most commonly in North America, which had no cities during the Middle Ages.

A factory or a group of factories stood near the centre of an industrial city. Nearby stood the cheap houses and apartment buildings where the poor people lived. The poor had no means of transportation, and so they had to

live within walking distance of their jobs. Many wealthy people, including merchants and factory owners, built big houses in the outer sections of the city. They owned horse-drawn carriages that took them to and from the central area. This pattern of living reversed that of earlier cities. In ancient and medieval times, most of the rich people lived in the inner city, and the poor people lived in the outer sections.

Industrial cities had sanitation problems similar to those of earlier cities. Rubbish and other wastes produced health hazards because of inadequate sanitation systems. In addition, a new problem—pollution from industry—became a health hazard. Factories polluted the waterways with chemical wastes and polluted the air with harmful gases. They also created huge dumps of rubbish, rusting metals, and other wastes.

The *gridiron pattern* of city blocks, which remains common today, came into widespread use in industrial cities. In this pattern, buildings are spaced more or less



The Industrial Revolution increased the production of goods, but it also brought miserable living conditions at first. Farm people in Europe and North America flocked to cities to take newly created jobs in factories. But like the Londoners above, most of them lived crowded together near the factories.

Engraving (1872) by Gustave Doré



Factories, such as those in Pittsburgh, Pennsylvania, U.S.A., *above*, turned out products quickly and cheaply. Factory workers, underpaid at first, later shared more in the profits that resulted from the factory system.

evenly apart and groups of them form rectangular blocks. Streets, generally of the same width, separate the blocks from each other. Most earlier cities had a more irregular arrangement of buildings and many winding streets. The regular pattern made it easy to extend a city in any direction. But it also gave a city a monotonous appearance.

The people. City populations increased greatly during the Industrial Revolution for two main reasons. First, the population of the world was increasing faster than ever. Second, improvements in agricultural methods had reduced the need for farmworkers. These workers flocked to the cities and took jobs in factories.

Manchester, England, and Chicago, U.S.A., provide examples of the tremendous growth of industrial cities. Manchester's population grew from about 6,000 in 1685 to about 303,000 in 1851. Chicago's population jumped from about 4,000 in 1840 to more than 1 million in 1890.

In the early years of the Industrial Revolution, most city people lived under miserable conditions. Men and women—and even many children—worked 12 or more hours a day in dark, dirty factories. They held monotonous, tiring jobs, such as tending a machine or carrying heavy materials. The factories had few safety rules, and accidents killed or injured many workers.

The workers earned barely enough money to feed themselves and their families. During economic slumps, factories laid off large numbers of workers who had nowhere to turn for relief. They could no longer farm the land for food, and governments had not yet begun to provide widespread relief for the needy. Sometimes workers rioted in protest against their living conditions.

The workers lived in poorly built, dirty *tenements* (crowded apartments), *row houses* (groups of houses without space between them), and even in cellars. At one time, about a sixth of the people of Liverpool, England, lived in cellars. The early industrial cities had widespread disease and high death rates. Pollution filled the air and the waterways, and rats and insects spread illness. The rich and the poor both fell victim to pollution and spreading disease. Until the 1830's, the homes of



Letchworth, England, *above*, was designed in the early 1900's along principles laid down by Ebenezer Howard. Howard and many other people tried to eliminate the crowded, dirty conditions of industrial cities. The plans for this town near London called for open space and for the separation of industrial and residential areas. Howard's ideas influence city planners today.

even most of the rich lacked plumbing for toilets and bathtubs. Most workers did not have these facilities until the late 1800's or early 1900's.

In time, the standard of living in most industrial cities improved. The mass production method used in the factories reduced the cost of making goods and thus cut the cost of the goods to customers. Many factory workers formed labour unions and threatened mass strikes to support their demands for higher wages and better working conditions. Finally, governments passed wage and welfare laws that helped the workers. The governments also took steps to improve sanitation.

A small percentage of the people had great wealth throughout the Industrial Revolution. Factory owners made huge profits from the business boom and paid their workers little. Bankers and financiers invested money in the new industries and made big profits on their investments. Merchants sold more and more goods as city populations grew. These rich people lived in large houses and could afford many luxuries.

During the 1700's and 1800's, charitable organizations and governments started free schools in many cities. These schools gave poor children a chance to have a formal education. But many of the teachers lacked good training, and many of the schools lacked textbooks. Also, many children could not even go to school because they had to work in factories. Children of wealthy families went to private schools or studied in their homes under tutors.

As in medieval times, the cities included people from a variety of backgrounds. People still tended to settle in neighbourhoods with others of the same background. But various groups had much more contact with each other than they had in medieval cities. People from all groups worked together in factories, and children from many groups attended schools together. The influence of the family on the behaviour and ideas of the individual remained strong. But the influence of people outside the family—fellow-workers, friends, teachers, and others—increased greatly.

Economy. The flow of workers from farms to cities rose tremendously during the Industrial Revolution. The manufacturing boom provided more jobs in cities than ever before. At the same time, technological advances in agriculture reduced the number of jobs available on farms. The invention of the reaper, for example, enabled one farmer to do the work of many.

Large numbers of craftworkers became factory workers. They made their products slowly, usually with hand tools. Factory workers, using machines, made products

much more quickly. Factory workers began to make many of the same products that the craftworkers made. These mass-produced goods were easier to make, and so they could be sold much more cheaply than the craftworkers' goods. Many craftworkers found that they could not compete with the factories.

The factory system of manufacturing began the greatest economic boom in history. With machines, people turned out products more quickly and cheaply than ever. The savings in production costs—together with fairer policies toward workers—resulted in greater earnings for workers. As their earnings increased, workers could buy more goods. The increased demand for goods led to increased production. Businesses built new factories and expanded existing ones. The new business created jobs for more people, and the new jobs meant that people had more money to spend. Thus, the demand for products increased again. This process of economic expansion is still going on.

Technological advances in transportation and communication aided the economic boom. The development of the steam-powered railway train gave businesses a way to send extremely heavy loads of products and raw materials over long distances. The railway became—and remains—the chief method of transporting goods across land. The invention of the telegraph and, later, the invention of the telephone made communication within and between cities more efficient than ever before. With these inventions, buyers could send and receive orders for goods more quickly than they could by using the mail.

Business executives had to spend enormous amounts to obtain raw materials, build factories, and make and operate machines. The cost was met in part through the use of the economic system called *capitalism*. Under capitalism, bankers and private investors put up money to help pay for business operations. Their investments entitle them to share in the business profits. In early industrial cities, only the wealthiest people could invest in businesses. But as time went on, many more people took part in the system.

Government. The rapid growth of city problems during the 1700's and 1800's forced governments to take steps to improve city life. Governments of industrial nations passed laws during the 1800's that were designed to help workers. These laws included measures that regulated child labour and provided income for injured workers and for families of workers who were killed at work. Other laws improved public health care and provided food and shelter for the unemployed.

Metropolitan cities

Cities have grown more than ever in the 1900's. In the mid-1980's, about 2,300 cities had more than 100,000 people, and about 225 cities had over 1 million people. Mexico City, the world's largest city, has a population of about 10 million.

An even more striking growth has taken place in the areas that lie near big cities. Large numbers of people have settled in these areas in the 1900's and have established communities there called *suburbs*. The great masses of people that had filled the cities are now

crowding both the cities and the land that surrounds them. See *Suburb*.

A city with suburbs is a *metropolitan city*, and the city and the area around it is a *metropolitan area*. The word *metropolitan* comes from Greek words meaning *mother city*. The Mexico City metropolitan area is the largest metropolitan area in the world. It has about 19 million people. The largest cities are all metropolitan cities. See *Metropolitan area*.

The population explosion has played an important



A metropolitan city is a giant community with suburbs nearby. In Los Angeles, *above*, and other metropolitan cities, major roads connect the centre of town and surrounding communities. These high-speed roads enable millions of people to travel from their homes in the suburbs to their jobs in the city.

part in the development of metropolitan areas. By 1990, the world's population was about five times as large as it was in 1850. This explosion led to overcrowded cities, causing many people to move to outlying areas. The population implosion, in which people moved from rural to urban areas, also helped build up metropolitan areas. The population displosion, in which people of various racial, religious, and national backgrounds moved into cities, also played an important part in the growth of metropolitan areas. After poor people and minority groups, such as blacks in the United States, moved into central cities, many well-to-do people moved out of the cities and into the suburbs.

Economic growth also aided the development of metropolitan areas. The booming economies of industrial nations helped millions of people achieve a high living standard. As a result, many people could afford expensive suburban homes.

The motor car, a major transportation advance of the 1900's, spurred the development of metropolitan areas and became a necessity of life for millions of people. In the 1890's, cars were so new and unusual that they were exhibited in circuses. Today, there are about 400 million passenger cars in the world. A majority of these cars are in advanced nations. The car makes it possible for millions of people to live far from their jobs, schools, and shopping centres (see *Car* introduction). The commuter railway, which carries many suburban workers between their homes and their jobs, also contributed to the de-

velopment of metropolitan areas. People can live in the suburbs and still work in the centres of cities.

Description. Today's cities are much larger than those of earlier times. In the late 1400's, for example, Paris covered about 8 square kilometres. The city now covers 105 square kilometres, and its metropolitan area stretches about 480 square kilometres.

Most metropolitan cities have a similar layout. The main business section, sometimes called *downtown*, lies in the centre of the city. It is the busiest part of the community. People from throughout the metropolitan area work in offices and stores there and shop in stores there. The business section covers a small area. But it can serve thousands of people daily because many offices and stores are located in tall buildings.

An industrial region of factories, warehouses, and shipping yards lies next to or encircles the main business section of many cities. The residential areas, where most of the people live, begin beyond the industrial region. The oldest and most run-down houses are in the residential area closest to the city centre. Most of the city's poor people live in this area, often called the *inner city*. Governments have undertaken urban renewal projects in many inner cities. Through these projects, some of the worst slum buildings have been replaced by new, low-cost housing. A large portion of this new housing consists of high-rise apartment buildings.

The neighbourhoods become newer and more attractive away from the inner city. The best homes stand near the edges of the city and in the suburbs. Each residential area has its own shops and other businesses. During the mid-1900's, many factories were built away from the central industrial sections of cities, especially in suburban areas.

The main streets of cities and suburbs are often jammed with cars, buses, and trucks. At such times, traffic creeps along slowly, delaying and angering large numbers of people. As a result, many wide major roads have been built to help carry the traffic. However, the number of motor vehicles has increased so greatly that traffic jams occur on these roads as well as on streets.

Many cities in developing nations still have poor rubbish and waste removal systems. But in general, the cities of other nations have adequate sanitation. On the other hand, these cities have another serious environmental problem—pollution. Motor vehicles, factories, electric power stations, and other sources create so much air pollution that it sometimes hangs in the air like dirty fog. Air pollution, somewhat like wastes of earlier days, threatens the health of the people who live in cities. In addition, city wastes that are poured into waterways kill fish. These wastes also make some waterways unfit for swimming.

The people. The population of urban places has continued to increase since the Industrial Revolution. Today, about two-fifths of the people of the world live in urban areas. Since 1945, suburban growth has been even more spectacular than the growth of cities has been.

On the whole, the people in the metropolitan areas of North America, Western Europe, and Japan have the highest standard of living in history. There are many more wealthy people and middle-income people than ever before.



Urban renewal has transformed slums into attractive, residential neighbourhoods in many metropolitan cities. These photographs of an urban renewal site in Chicago show how run-down buildings, *left*, have been replaced by modern, low-cost housing, *right*.

Most of the people who live in metropolitan areas have good housing, send their children to well-equipped schools, and can afford the necessities—and many luxuries—of life. Workers in all occupations have benefited from the booming economy and from the increased strength of the labour movement during the 1900's. However, as has been true throughout history, many people live in poverty.

The existence of poverty amid great wealth ranks among the chief problems of today's cities. The poor want to share in the general wealth, but many are unable to better themselves economically. They may lack the education or training that could help them get good jobs. Many people are denied a good education, a good job, or good housing because of some kind of discrimination.

Most of the poor people live in the inner city. This area is characterized by run-down apartment buildings that are crowded and close together. Many of the apartments have been divided so that more than one family lives in quarters originally intended to be used by a single family.

A large percentage of the people in neighbourhoods just beyond the inner city are classified by sociologists as *lower middle class*. These people live more comfortably than the poor people, but not nearly so well as the people farther out. Most of the houses are old and small. But they are in better condition and are less crowded than housing in the inner city.

Most middle-class and wealthy people live near the edges of the city or in the suburbs. Their houses are bigger, newer, and more luxurious than the houses closer in. Many of these homes have large backyards where

families can play and relax in privacy. During the mid-1900's, many luxury apartment buildings went up in the suburbs. Some others were built near the city business section.

In the 1900's, there has been a gradual movement by people to the outer parts of cities and to suburbs. This movement increased greatly after World War II (1939-1945). People move out to get away from areas with high crime rates and to have better housing and cleaner, quieter, and less crowded living conditions. They also believe that their children can get a better education than in the inner city. Schools in the inner cities have been widely criticized as being too poorly equipped to educate children properly.

Economy. The economic boom that began during the Industrial Revolution of the 1700's and 1800's is still going on, and the markets for products made in cities continue to grow. The population explosion has created more buyers for more goods, and higher standards of living make it possible for people to buy an increasing volume of products. Many nations have expanded their trade with other nations, creating new markets for their products. Technological advances have also made many new products available. The economies of advanced nations rely heavily on massive sales of such products as cars, electric and gas stoves, refrigerators, television sets, and automatic washing machines and dryers.

Metropolitan cities, like industrial cities, are manufacturing centres that provide jobs for thousands of factory workers. But today's cities also have large numbers of jobs for workers in hundreds of other fields. Salespeople sell the products of industry, and transportation workers move the products from place to place. Office

workers help keep businesses running smoothly. Construction workers build the offices and factories that are needed by expanding businesses and put up the housing units for the expanding population. To manage the affairs of cities, governments employ accountants, fire fighters, police officers, health specialists, lawyers, road-builders, tree trimmers, sanitation workers, and many other groups of employees.

Economic growth in the 1900's has been aided by hundreds of technological advances. They include the use of electricity and petrol to run machines and the development of plastics and other materials to make new products. Other technological advances have been radio, TV, and the space satellite for communication; the car and aeroplane for transportation; and the computer to handle information needed by complex economies.

Jobs created by technological progress include those of aeroplane pilots, computer operators, electricians, mechanics, and petrol station attendants.

Economic activity in metropolitan areas has become increasingly decentralized. Many business firms have built factories in the suburbs while keeping their main offices in the city.

Government. The governments of metropolitan cities have grown into large, complex organizations. They face the challenging tasks of providing services for thousands or millions of people and of helping rebuild aging, decaying parts of cities. They are hard-pressed to get the funds they need to do their work, and their problems increase as urban populations continue to grow. For further information, see the *Governmental problems* section of this article.

City problems

Cities are the cultural, economic, governmental, population, transportation, and communication centres of the world. They are places where most people can find a job and earn a living and where some people can accumulate moderate or great wealth. In cities, people can also choose from a variety of cultural and recreational activities that add to the enjoyment of life. Nevertheless, cities have many physical, social, economic, and governmental problems.

Physical problems of cities include substandard housing, pollution, and traffic congestion.

The term *substandard housing* refers to poorly constructed, run-down, insanitary, or overcrowded dwellings. In developing nations, millions of people live in crude shacks or other dwellings that barely provide shelter. The people of advanced nations are better off. Even so, some housing in advanced nations is also sub-

standard. In the early 1970's, about 5½ per cent of the occupied urban housing units in the United States were considered to be substandard. Governments have set up programmes to get rid of substandard housing and to provide decent housing for needy families. However, population growth, lack of funds, the high cost of construction, and other factors continue to cause a worldwide housing crisis. Substandard housing and attempts to solve the problem are discussed in detail in the *Housing* article.

Motor vehicles, factories, electric power plants, and other sources pollute city air with fumes that endanger the health of the people. Wastes from factories and other sources pollute waterways. But the same things that cause pollution also aid a city's economy and give its people conveniences. A government might want to end pollution immediately by eliminating all sources of



Substandard housing is one of the most serious city problems. In spite of government efforts to improve housing, many dwellings like the shacks in New Delhi, India, *above*, remain.



Travel in cities is often difficult. People must crowd into trains and buses and drive on congested roads. In Tokyo, *above*, workers called *pushers* cram passengers into the trains.

pollution. But to do so, it would have to close factories and electric power stations and prohibit cars—and thus cripple the economy of the community and inconvenience the people. Instead, governments, industry, and science must seek ways to reduce pollution without upsetting the urban way of life. See **Air pollution**; **Water pollution**.

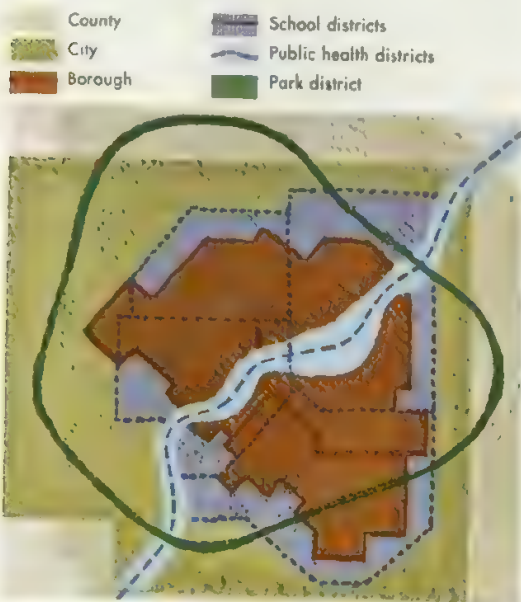
At any time—but especially during the morning and evening rush hours—the main streets of cities and suburbs can become jammed with motor vehicles. Such traffic jams delay and anger people trying to get to and from work and other places. Governments have built new roads, tried to improve public transportation, and taken other steps to try to relieve traffic congestion. Even so, getting from place to place in a metropolitan area becomes more and more difficult because of population growth and the ever-increasing use of cars.

Social problems in today's cities include friction between people of different backgrounds; and crime, juvenile delinquency, alcoholism, and drug addiction. Poverty—which is both a social and an economic problem—is discussed in the *Economic problems* section of this article.

The population dispersion has led to conflicts between groups of people. Often, groups with different cultural backgrounds fear and distrust each other and view each other's way of life as inferior. Such attitudes have caused violence between groups. Examples in the 1900's include conflicts between Protestants and Roman Catholics in Northern Ireland; Hindus and Muslims in India and Pakistan; blacks and whites in South Africa and the United States; and language groups in India. In some places, governments have passed laws to protect

Metropolitan area governmental units

This diagram shows some of the governmental units that may operate within a metropolitan area. Solutions to problems affecting the whole area are difficult, partly because no one unit has authority over the whole area.



minority groups from injustices. But group conflicts will continue until people learn to live together peacefully.

Such antisocial behaviour as crime, juvenile delinquency, alcoholism, and drug addiction arises in part from the inability of some people to adjust to urban living. Sociologists point to urban society's impersonal relationship toward individuals as a cause of this inability. Some people come to feel that they have no place in society. They may turn to crime or delinquency as a way of lashing out at society or making material gains. Or they may seek escape from society through overuse of alcohol or drugs. Stricter law enforcement might help reduce antisocial behaviour, but the problem cannot be eliminated completely until its causes are eliminated. Private and governmental organizations have been established to try to reduce antisocial behaviour. These groups publicize the dangers of such behaviour. They also work with former convicts, juvenile delinquents, alcoholics, and drug addicts to help them overcome their problems and find places in society.

Economic problems. Most people in the cities of advanced nations enjoy a high standard of living. But even in the best times, a city has many poor people. Poverty has always existed, but the great wealth of today's cities highlights the problem. The poor see other people enjoying comfortable lives, and their resentment toward their own condition grows. The anger felt by the poor toward society has sometimes led to riots. Governments, individuals, and charitable and social action organizations work to eliminate poverty. They try to improve educational and job opportunities for the poor, and they provide many poor people with financial aid. For a detailed discussion of the problem and steps taken to solve it, see **Poverty**.

Complex economic and social factors sometimes lead to business slumps. During a slump, many workers lose their jobs and the number of needy people in cities increases. The workers can collect unemployment pay from the government, but this pay is much less than their usual income. Unemployed workers cut down on their buying, and business suffers further.

Governmental problems. Through the years, the job of governing cities has become increasingly complex. Today, city governments find themselves hard-pressed to rebuild aging, decaying areas and to provide satisfactory schools, police protection, and other necessary services. Population growth and change, lack of funds, lack of authority, and conflicting authority all contribute to the difficulty of governing cities.

The constant growth of city populations means that city governments have to provide services for an ever-increasing number of people. Also, many people who move into cities are poor and many who move out are well-to-do. This development means that city governments must provide financial assistance for a larger part of the population. It also means that the people who live in the cities are less able to pay for services provided by the government. Well-to-do people who move to suburbs may continue to earn a living in the city, but these people no longer pay taxes to support its government. A city's tax base also shrinks when industries move to suburbs. Central governments contribute to the cost of operating cities. Yet, despite such aid, cities face a serious financial crisis.

A city government is part of a complex authority system. Each city government is subject to the regulations of its central government. In some countries, cities are also subject to the regulations of regional governments, such as those of states and provinces.

In some countries, a city may adopt its own form of government and have considerable freedom in local matters. In other cases, the central legislature decides what form of government a city will have. It also decides many city government policies, such as the kind of and rate of taxation. Legislators from rural areas often vote against measures designed to help urban areas. Thus, central government control of city affairs can sometimes cause problems for city governments.

Many separate governmental units operate within most metropolitan areas. These units include city, suburban, county, and township governments; school districts; and special districts. Special districts include governmental units that provide for rubbish collection, mosquito control, sewage disposal, and park management. No one governmental unit has authority over the entire area. Therefore, no one unit has the authority or the responsibility for dealing with such areawide problems as pollution and the flow of mass transportation.

Metropolitan governments have been established in some metropolitan areas to provide an overall authority. A metropolitan government is responsible for an entire metropolitan area's police protection, water supply, mass transportation, and other services that can be han-

dled most efficiently by an areawide authority. Many people oppose this form of government. They fear that it results in higher taxes, and they believe only small local governments can remain close to the people.

For more details on the functions and problems of local governments today, and of their relations with higher levels of government, see **Local government**.

Solving city problems. Cities have made some effort to solve their problems, but much remains to be done. More money than is now available could partially solve some of the problems. Most of the funds would come from taxes paid by citizens and businesses. Some people favour extensive use of tax money for social improvement, but others oppose it. Government regulation can also be used to help solve problems. For example, governments can demand that car manufacturers make cars that pollute the air less than today's vehicles do. Again, some people favour extensive government regulation as a solution, but others oppose it.

All city problems could not be solved completely even if everyone favoured wide use of tax money and government regulation. Some governments simply could not get enough money to relieve such problems as poverty and substandard housing. Also, money cannot change the attitude of one group of people toward another. In addition, government regulation has limited usefulness in solving such problems, as the example of pollution control in the *Physical problems* section of this article illustrates.

Future cities

Sociologists have made various predictions about urban communities of the future. They believe that metropolitan areas will continue to grow in both population and area. In 1988, about 2½ billion people in different parts of the world lived in urban places. By the year 2000, the number is expected to rise to about 3 billion people.

Some new urban communities have already been built in the 1900s, and more will be built by 2000. Like today's suburbs, the new communities will provide living space and ease the overcrowding problem caused by the population explosion and implosion. City planners hope that—unlike most suburbs—the new communities will also provide jobs for most of their residents. If the communities do so, the overcrowding of cities will be eased even more.

Communities that have such a self-supporting feature are called *new towns* or *new cities*. Great Britain and the Scandinavian countries have been leaders in developing new towns. The governments of these nations provided much financial aid for this development. In the United States, where private enterprise plays the major role, only a few new towns have come into existence through such financially supported development.

Brazil built a new capital city, Brasília, in the mid-1900s. The Brazilian government located this city in the thinly populated interior of the country. It hopes that an important, modern city there will lead to further development of the interior.

The development of new towns and cities is a slow, costly process. Private developers are reluctant to take

on such projects because of the uncertainty of—and the long wait for—profits. Many governments have been unable or unwilling to finance such projects. For these reasons, sociologists predict that almost all the additional millions of people who will live in urban places by the year 2000 will crowd into existing communities. More and more of the land around central cities will be filled by people. The suburbs will spread out so far that some metropolitan areas will run together with no rural areas between them. Such a continuous stretch of metropolitan areas is called a *megapolis*.

Sociologists also foresee physical changes in metropolitan areas. Most of them expect governments to play a greater role in getting rid of slums and in planning urban areas and regulating their affairs. To absorb the increasing population, tall buildings may be permitted in areas where they are now prohibited. Governments may also set aside much more land for parks and other recreational areas. They may try to solve traffic problems and improve safety by creating separate roadways for cars, trucks, and pedestrians. See the article on **Town planning**.

The effort to free cities of pollution seems sure to continue. Entire urban communities may even be enclosed in plastic domes. Temperature and humidity inside the domes would be controlled, and electronic filters would keep the air clean and fresh. Even so, there may still be problems for human beings living in such a sanitized environment. It is hoped that future cities and suburbs will offer the advantages of urban life without the disadvantages.

Study aids

Related articles. *World Book* has separate articles on hundreds of cities. These are listed at the end of the articles on the country in which they are situated. See also the following articles:

History	
Athens	Guild
Babylon	Industrial Revolution
City-state	Middle Ages
Egypt, Ancient	Phoenicia
Free city	Rome (The ancient city)
Greece, Ancient	Rome, Ancient

City problems	
Air pollution	Riot
Crime	Segregation
Drug addiction	Traffic (Traffic problems)
Environmental pollution	Waste disposal
Juvenile delinquency	Water pollution
Poverty	

Other related articles	
Architecture	Park (Kinds of parks)
Communication	Playground
Community	Population
Education	Suburb
Housing	Technology
Local government	Town planning
Megalopolis	Transportation
Metropolitan area	

Outline

I. How cities began and developed

- A. Advances in technology
- B. Physical environment
- C. Social organization
- D. Population growth

II. Ancient cities

- A. Description
- B. The people

- C. Economy
- D. Government

III. Medieval cities

- A. Description
- B. The people

- C. Economy
- D. Government

IV. Industrial cities

- A. Description
- B. The people

- C. Economy
- D. Government

V. Metropolitan cities

- A. Description
- B. The people

- C. Economy
- D. Government

VI. City problems

- A. Physical problems
- B. Social problems
- C. Economic problems
- D. Governmental problems
- E. Solving city problems

VII. Future cities

Questions

- What are some of the reasons that so many people live in and near cities?
- What are some of the problems of cities?
- What is the *population explosion*? The *population implosion*? The *population displosion*?
- How did medieval cities solve the problem of overcrowding?
- How did people of ancient cities try to please the gods?
- What is a *megalopolis*?
- What European city remained a trading centre throughout the Middle Ages?
- How did the decline of manorialism contribute to the growth of cities?
- Why can a city business section that covers a small area serve thousands of people daily?



The City of London contains many major financial institutions, such as the Bank of England and the Stock Exchange.

City of London (pop. 5,400), often known simply as *The City*, is the financial and business centre of the capital. It is one of the most important commercial centres in the world. In its 274 hectares lie the headquarters of all Britain's major banks, many insurance companies, and brokers. Few people live in The City, but nearly 400,000 people travel there every day to work. The City of London is governed by its *Corporation*, which consists of a Lord Mayor, 25 aldermen, and 133 common councilmen. The Barbican, an important development, is in the City of London. The Barbican includes an arts and conference centre.

See also *Guilds*; *Livery companies*.

City-state is an independent or nearly independent state in which political and cultural activities are concentrated in a single urban centre. City-states were often ruled by a king, by a dictator, or by a small group of powerful citizens. In some cases, political life was controlled by city dwellers, and in other cases by people of both the countryside and the city.

The city-state had its fullest development in ancient times. The most famous examples were Athens and Sparta in Greece, and Rome before the formation of the Roman Empire in 27 B.C. During the Middle Ages, which lasted from about A.D. 500 to 1500, some German and Italian cities in the Holy Roman Empire became self-governing and almost entirely independent. They included Florence, Genoa, Milan, and Venice in Italy, and Bremen, Hamburg, and Lübeck in Germany.

Related articles in *World Book* include:

Athens (Earliest times)	Hittites (History)
Ebla	Italy (Rise of the city-states)
Free city	Phoenicia (Government)
Greece, Ancient	Sparta

Ciudad Bolívar (pop. 249,590) is a major port and commercial city on the Orinoco River in eastern Venezuela. For location, see *Venezuela* (political map). The port at Ciudad Bolívar has a large floating pontoon dock. Such goods as animal skins, cashews, latex, palm fibres, and timber pass through the port. The city also ships gold and diamonds from the Guiana Highlands in southern Venezuela.

The Spanish founded what is now Ciudad Bolívar in 1764. They named it Angostura. In 1819, under the leadership of General Simón Bolívar, the Congress of Angostura organized the republic of Gran Colombia, which included what are now Venezuela and Colombia. Venezuela was liberated in 1821, and Angostura was renamed *Ciudad Bolívar*, the Spanish for *Bolívar City*.

Ciudad Juárez. See Juárez.

Ciudad Trujillo. See Santo Domingo.

Civet is a furry mammal that looks somewhat like a long, slender cat. But a civet has a more pointed snout, a fluffier tail, and shorter legs than a cat. Civets live in Asia from India to Indonesia, and in Africa.

Civets vary in colour and size. Their fur may be black, brown, grey, or tan. Most species, including the *banded palm civet* of Asia and the *African civet*, have dark spots or splotches, and the tail has rings of light and dark fur. A few species—such as the *masked palm civet* and the *small Indian civet*, both found in Asia—have a plain coat or only faint spots. Civets range from about 33 centimetres to about 97 centimetres long. In addition, their muscular tail is sometimes as long as the rest of the body. Civets use their tail to grasp branches and to steady themselves while climbing trees.

Civets live within a specific area called a *territory*. Most kinds of civets climb well and spend much of their time in trees. Some civets sleep in tree holes or among tangled branches. A few species live mostly on the ground and dig burrows. Civets move about chiefly at night. They live alone, except for females and their young. Most civets eat birds, frogs, insects, rodents, and small reptiles. Civets also eat fruit and other parts of plants and the eggs of various animals. Palm civets feed chiefly on plants.

Civets help people by feeding on mice and rats, but they also may eat chickens and raid fruit orchards.

Civets mark their territory with a foul-smelling liquid from a gland near the base of the tail. Perfume manufacturers have used the liquid, called *civet musk*, from several species, especially the *African civet*. Civet musk makes the odour of perfume last longer.

Scientific classification. Civets belong to several genera in the family Viverridae.

See also Mongoose.

Civil code. See Code Napoléon.

Civil defence, also known as *civil protection*, is a government-sponsored programme designed to save lives and property if an enemy attacks a country in wartime. It provides rescue and relief for people suffering the effects of natural disasters such as floods, blizzards, earthquakes, volcanoes, fires, storms and explosions. Civil defence organizations also plan to reduce the consequences of terrorist incidents, such as bombings, and major pollution or nuclear accidents.

Many countries have civil defence organizations run by national or local governments. Most were originally set up to prepare for wartime emergencies. In the United Kingdom civil defence played a notable part during World War II (1939-1945). Observers spotted approaching enemy bombers, air raid wardens alerted civilians, and rescue workers freed people trapped in bombed buildings.

In the 1960's and 1970's, the main concern worldwide was how to cope with the aftermath of a nuclear attack. Some countries built underground bunkers to protect government officials and key workers from nuclear bomb blasts, and issued advice to their populations on what to do in the event of a nuclear attack. Others, such as Sweden, built shelters to protect most of its civil population and sustain them for several months.

By the early 1990's, the Soviet Union—one of the major participants in the Cold War—broke up into separate republics and the nuclear threat all but vanished. The main concern for governments was to protect people against peacetime disasters. In the United Kingdom, local government authorities are responsible for civil defence in cooperation with the Home Office, a department of national government. The arrangements are designed to tackle all kinds of emergency, not just war. Warnings would be given by radio and television broadcasts. Ireland formed a civil defence corps in 1951. County civil defence officers liaise with various government departments. Among the tasks undertaken by some 1,200 volunteers are crowd control at sports events. In India and many other countries, the army is mobilized to support civilian aid workers when disaster strikes. In New Zealand, all public sector departments have plans to enable them to go on working in an emergency, such as an earthquake. Australia has a Natural Disasters Organization, with each state and territory run-



A civet has a long, slender body, short legs, and a long, muscular tail. Civets live in Africa and in parts of Asia. The *African civet*, left, has greyish fur with dark spots or splotches.

ning local services which tackle bushfires and other disasters. Australia has about 250,000 volunteer bushfire fighters.

Civil protection officials and volunteers work closely with military, police, firefighting and medical services. Voluntary organizations such as the Saint John Ambulance, the Red Cross and Red Crescent Societies, also provide aid to disaster victims. The United Nations declared the 1990's the International Decade for Natural Disaster Reduction, and called on all governments to set up civil protection programmes.

Civil disobedience is the deliberate and public refusal to obey a law. Some people use civil disobedience as a form of protest to attract attention to what they consider unjust or unconstitutional laws or policies. They hope their actions will move other people to correct the injustices. Other people regard civil disobedience as a matter of individual religious or moral conviction. They refuse to obey laws that they believe violate their personal principles.

Most lawbreakers try to escape punishment. On the other hand, people who practise civil disobedience accept willingly their punishment for breaking the law. In this way, they can dramatically demonstrate their deep concern about the situation they are protesting against.

Many lawbreakers use violence. But most acts of civil disobedience are nonviolent. Civil disobedience is usually distinguished from riot, rebellion, and other types of violent opposition to law and authority.

Is civil disobedience ever justified? Throughout history, there has been widespread disagreement concerning the use of civil disobedience in a society based on law and order. Some people claim that citizens are obligated to disobey laws they consider unjust, such as laws segregating the races. They say that such lawbreaking may be the best way to test the constitutionality of a law. Some defend the use of civil disobedience by pointing to Nazi Germany's laws calling for extermination of Jews and other groups.

Other people claim that it is never right to break a law deliberately. They argue that defiance of any law leads to contempt for other laws. Any act of civil disobedience, they believe, weakens society and may lead to violence and *anarchy* (no government or law).

Many people approve civil disobedience only in extreme circumstances, and then only if it is nonviolent. They argue that injustices can usually be corrected legally through democratic processes. Free elections give people a chance to choose their leaders and express their views. Various constitutional provisions also protect the right of dissent and protest.

In the United States, during the 1950's and 1960's, Martin Luther King and other civil rights workers deliberately violated Southern segregation laws as a means of fighting racial injustice. Many opponents of the Vietnam War (1957-1975) committed various illegal acts in attempts to change U.S. policy. During the 1980's, nonviolent protests were directed at the repressive racial policy of *apartheid* (segregation) of the minority white government in South Africa.

See also the articles **Gandhi, Mohandas K.**; **India, History of** (Gandhi and the satyagraha campaign); **King, Martin Luther, Jr.**; **Pankhurst, Emmeline**; **Coulden, Thoreau, Henry David** (His beliefs and works).

Civil engineering. See **Engineering** (The branches of engineering).

Civil law is a term with several meanings. The term is often used to describe the rules of private law and to set them apart from the rules of criminal law. Used in this way, civil law covers such matters as contracts, ownership of property, and payment for personal injury. Criminal law deals with actions that are harmful to society.

The term *civil law* can also mean the law of most European countries, as opposed to the *common law* of England and other countries that have adopted a similar system. Under this type of civil law, *codes* (sets of rules) approved by legislatures are the primary sources used by judges to decide cases. Under common law, judges base their decisions chiefly on previous court decisions in similar cases. See **Common law**.

Originally, civil law referred to the code of laws collected by the Roman emperor Justinian in the A.D. 500's. These laws were used to govern the Roman Empire. A new civil law became popular in most of Europe after it took effect in France in 1804. This law, called the *Code Napoléon* or *Code Civil*, combined the Roman law and the law of northern France.

Related articles in World Book include:

Code Napoléon	Law (Private law; The development of law)
Contract	
Court	Negligence
Damages	Suit
Equity	Tort
Fraud	Trespass
Justinian Code	

Civil liberties. See **Civil rights**.

Civil List is the state financial account that pays for the maintenance of the sovereign and the Royal Family in the United Kingdom. The amounts involved are fixed by Parliament at the beginning of each reign. In return, the exchequer receives the annual revenues from some of the lands owned by the sovereign. Under the Civil List Act, 1975, the Treasury can increase the amount of the payment annually to keep up with rising costs.

The Civil List Act of 1952, passed when Queen Elizabeth II came to the throne, authorized a yearly payment to the Queen of £475,000. This amount has increased by stages to more than £4 million. Ever since 1975, the Queen has contributed to the Civil List from her own resources. Approximately three-quarters of the expenditure covered by the Civil List is on salaries of the royal household. Other payments are made to Queen Elizabeth the Queen Mother, Prince Philip, Princess Margaret, and the Princess Royal.

Civil rights are the freedoms and rights that a person may have as a member of a community, state, or nation. Civil rights include freedom of speech, of the press, and of religion. Among others are the right to own property, and to receive fair and equal treatment from government, other persons, and private groups.

In democratic countries, civil rights are protected by law and custom. The constitutions of many democracies have *bills of rights* that describe basic liberties and rights. Courts of law decide whether a person's civil rights have been violated. The courts also determine the limits of civil rights, so that people do not use their freedoms in order to violate the rights of others.

In many nondemocratic countries, the government claims to respect and guarantee civil rights. But in most

of these countries, such claims differ greatly from the actual conditions. In some Communist countries, for example, the people are denied such basic rights as freedom of speech and of the press. Yet their constitutions guarantee these rights.

Some people draw sharp distinctions between *civil liberties* and *civil rights*. They regard civil liberties as guarantees to a person against government interference. They think of civil rights as guarantees of equal treatment for all people. For example, civil liberties would include freedom from government interference with a person's right to free speech. Civil rights would include the right of all people to receive equal protection of the law. Civil rights often refers to the condition and treatment of minority groups. In this article, the term *civil rights* refers to both civil liberties and civil rights.

Limits of civil rights

All civil rights have limits, even in democratic countries. For example, a person may be denied freedom of speech in a democracy if it can be shown that his or her speech might lead to the overthrow of the government. A person may not use civil rights to justify actions that might seriously harm the health, welfare, safety, or morals of others.

A person may be denied a civil right if that right is used to violate other people's rights. Freedom of expression, for example, does not permit a person to tell lies that ruin another person's reputation. Property owners have the right to do what they choose with their property. However, this right may not allow a person legally to refuse to sell property to a person of a certain race or religion. This is because the property owner would be denying the other person equal freedom of choice.

Examples of civil rights

The basic civil rights recognized by most democratic countries are freedom of speech, freedom of the press, and the right to peaceful assembly. These rights are guaranteed under the constitutions of many countries.

Legislation may guarantee other rights concerned with the process of law. These include protection against arrest and detention without good reason, the right to jury trial, and protection against being tried twice for the same offence. In addition, people and property may not be wrongfully searched or seized and excessive or unusual punishments may not be inflicted.

Rights against discrimination protect minority groups and ensure equal rights and opportunities for all people regardless of race, sex, religion, age, or disability. Laws exist in many countries to give equal rights to all men and women regardless of their race or religion. But in some countries, discrimination on racial or religious grounds is part of government policy.

Rights to form trades unions are intended to protect workers from exploitation by their employers. In many countries, workers are still fighting for the right to organize and to campaign for better pay, improved working conditions, and the right to strike.

Campaigning for civil rights

Most civil rights campaigns consist of public meetings, marches, and other protests, such as people sitting

down on a public highway. Such campaigns make other people aware of the issues and demonstrate popular support. They also include taking test cases to court and lobbying parliamentarians in an effort to change legislation.

One of the most bitter civil rights campaigns was that of black Americans in the United States, who campaigned for equal rights from the 1800's. This campaign continued through the 1900's, and led to a major protest movement during the 1950's and 1960's which resulted in important civil rights legislation to end discrimination against black Americans.

Since the 1970's, when antidiscrimination laws were passed in many countries, civil rights campaigns have emphasized *affirmative action* to counteract past discrimination. Provisions may be made to encourage the employment of disadvantaged groups or to give them special help in education. But this raises a number of other civil rights issues. For instance, white men may complain that they are discriminated against because priority is given to black people and to women. Some religious groups may demand their own schools or single-sex education, whereas other people are working to encourage mixed education for children of all races and religions.

Development of civil rights

Natural law. The idea that people have certain rights that cannot be taken away probably began thousands of years ago with the theory of natural law. This theory states that a natural order exists in the universe because all things are created by nature, or God. Everything has its own qualities and is subject to the rules of nature to achieve its full potential. According to this theory, anything that detracts from a person's human qualities, or prevents their full achievement, violates the laws of nature.

The ancient Greek philosophers and the writers of the Old Testament stressed that there is a higher law than human law. In the first century B.C., the Roman philosopher Cicero insisted that this higher (natural) law is universal and can be discovered through human reason. This idea led to the belief that governmental power has limits, and that people and governments everywhere are bound by natural law.

Some of the most historic English legal documents are based on the principles of natural law. The earliest and most famous was Magna Carta, which the king approved against his will in 1215. The document placed the king himself under the law. In 1628, the English Parliament drew up a Petition of Right. The petition claimed that certain actions of the king, such as levying taxes without the consent of Parliament, were unconstitutional.

Natural rights. Natural law had always stressed the duties more than the rights of government and individuals. But during the late 1600's, the natural law tradition began to emphasize natural rights. The change was brought about largely by the writings of the English philosopher John Locke.

Locke argued that governmental authority depends on the people's consent. According to Locke, people originally lived in a state of nature with no restrictions on their freedom. Then they came to realize that confu-

sion would result if each person enforced his or her own rights. People agreed to live under a common government, but not to surrender their "rights of nature" to the government. Instead, they expected the government to protect these rights, especially the rights of life, liberty, and property. Locke's ideas of limited government and natural rights became part of the English Bill of Rights (1689), the French Declaration of the Rights of Man (1789), and the U.S. Bill of Rights (1791).

Today, many scholars reject the natural law and natural rights theories. These scholars believe that all laws—including those guaranteeing civil rights—are simply devices that people find convenient or useful at a particular time. Nevertheless, nearly all civil rights laws have resulted from the theories of natural law and natural rights.

Civil rights today. Civil rights have long been protected in the constitutional democracies of Western Europe. These nations include France, Great Britain, Switzerland, and the Scandinavian countries. Personal liberties are also secure in such newer democracies as Australia, New Zealand, Canada, and the United States. Many new nations of Africa and Asia have adopted constitutions that guarantee basic civil rights. But in many of these countries, unstable governments and inexperience with self-rule have often led to political arrests, censorship, and other denials of civil rights.

Most nondemocratic governments claim to protect civil rights. But in practice, they grant civil rights only when they find it politically convenient to do so. The civil rights tradition is weak in many Latin-American countries. Most Communist nations have constitutions that guarantee the people basic rights and liberties, but the governments have seldom enforced these rights. China's Constitution, for example, guarantees the right to vote and assures freedom of speech, of the press, and of assembly. But China's Communist Party completely controls the government, and the Chinese people may be punished if they publicly criticize the party. The Chinese government controls the newspapers and other forms of communication.

The United Nations General Assembly adopted a Universal Declaration of Human Rights in 1948. It states that all people are born free and are equal in dignity and rights. Many experts in international law believe that the declaration lacks legal authority, but most agree that it has high moral authority.

Related articles in World Book include:

Bill of Rights	Jury
Censorship	Magna Carta
Citizenship	Minority group
Class action	Northern Ireland (History)
Declaration of Independence	Petition of Right
Democracy	Privacy, Right of
Feminism	Rights of Man, Declaration of
Freedom	the
Freedom of religion	Search warrant
Freedom of speech	Segregation
Freedom of the press	Trial
Habeas corpus	Wiretapping
Human Rights, Universal Declaration of	Women's movements

Civil rights movement. See Civil rights.

Civil service consists of people employed by the state to run the public services of a country. For example, the officials running a country's foreign service, its taxation

department, and its public health department are all civil servants. In many countries, policemen and schoolteachers are employed directly by the state, and are regarded as civil servants. In some countries, the senior officials of state-controlled public enterprises are also regarded as civil servants. In most countries, people serving in the armed forces or working in *local government* are not civil servants (see *Local government*).

The civil services of most countries are open to all the citizens of those countries, without distinction of class, creed, or colour. But, generally, the civil services require from entrants a certain standard of education or a certain amount of practical experience. In some countries, certain posts may be filled only by people with special regional or sectional interests.

Most countries try to protect their civil servants from private pressures and influence. States expect their servants to be free from corruption, and they expect them to avoid using their powers to advance the interests of private groups and individuals.

Work of civil services. Originally, civil services dealt only with such matters as defence, foreign affairs, justice, finance, and internal law and order. But, during the 1900's, many countries greatly increased the range of social services provided by the state. In many countries today, more people work in the new services than in the traditional ones. These new services deal with such matters as insurance, health, employment, and education.

In Communist countries, central ministries control all fields of social, political, and economic activity. For this reason, the civil services in these countries are vast and influential organizations. But the activities of civil services in Communist countries are always under the strict political control of the Communist party.

In a *federation*, the work of running the civil services is divided between federal and provincial authorities. See **Federalism**.

History. The great empires of Egypt, China, and Rome owed much to the work of their civil services. Many of the rules of civil administration stem from these ancient civil services.

In the Middle Ages, the Roman Catholic Church was a *temporal* (worldly) power as well as a religious organization. It possessed the most effective civil service in Europe. The Church inherited its *bureaucracy* (organization of offices) and *hierarchy* (organization of ranks) from the Roman Empire.

The civil services of today in many countries of Africa, Asia, Europe, and Latin America are modelled on those created by Frederick II in Prussia and Napoleon I in France in the 1700's and 1800's. The civil services of today in Britain and the United States are based on reforms carried out in the second half of the 1800's. Until the 1700's and 1800's the governments of most countries nominated people to civil offices on the basis of their usefulness to the government and as rewards for political services. This practice, called *patronage*, led to inefficiency and corruption.

Countries that do not have civil services, and countries in which the civil services do not function properly, sometimes become the victims of military dictatorships. In these countries, the army may represent the only organized source of authority.

Civil War, American. See American Civil War.



Engraving by T. Besser after fresco in the House of Commons by C. W. Cope

The English Civil War began on Aug. 22, 1642, when the Royalist forces under Charles I raised the King's standard at Nottingham.

Civil War, English

Civil War, English, was fought between the forces of King Charles I and those of the English Parliament. The war took place in two parts. The first part lasted from 1642 to 1646, the second from April to November, 1648. It led to the execution of Charles I in 1649 and the defeat and exile of his son, later Charles II, in 1651.

Causes of the Civil War

Before the Civil War, the English monarch ran the national government with the aid of ministers. Parliament took a less important part in state affairs than it does now. The first Stuart king, James I, reigned from 1603 to 1625. He wanted to rule as an absolute monarch. But Parliament did not share his views. His son, Charles I, called three Parliaments between 1625 and 1628, and had trouble with each. After *dissolving* (ending) the third in 1629, he ruled without Parliament at all until 1640.

Economic causes. Inflation forced up prices in all parts of Europe between 1530 and 1640. It drastically reduced the value of the monarch's income. James I spent money lavishly, but Parliament refused to give him more. He responded by levying new import duties.

In 1625, Parliament refused to grant Charles I *tonnage and poundage* (the customs duties that normally provided much of the monarch's income). Charles forced property owners to lend him money and imprisoned those who refused. In 1628, Parliament passed the *Petition of Right*, forbidding the King to raise any taxes without its consent. Charles accepted the Petition, but insisted that it did not apply to customs duties. In the 1630's, he evaded the Petition by collecting *ship money* (see *Ship money*).

Religious causes. For many years, a radical group within the Church of England, the *Puritans*, sought to do away with bishops and revise the Prayer Book. James I resisted the Puritans. Charles fought against them, working with a reactionary group of churchmen led by Wil-

liam Laud. He made Laud Archbishop of Canterbury in 1633. The Puritans accused Charles and Laud of leaning towards Roman Catholicism. Charles's wife, Henrietta Maria, was unpopular because she was Catholic and because she was the sister of Louis XIII of France. Laud was also unpopular because he encouraged Charles's belief in the *divine right of kings* (the idea that kings were appointed by God and ruled on God's behalf).

War with the Scots. In 1638, the Scots rebelled against Charles when he tried to impose the English Prayer Book on their Presbyterian Church. Charles mounted an expensive campaign against the Scots in 1639, but it failed. His most able minister, the Earl of Strafford, advised him to summon a Parliament to raise money for another campaign in Scotland. The *Short Parliament* met in April 1640, but refused to vote further taxes until the King dealt with its complaints. Strafford advised Charles to dissolve it after only three weeks. The Scots then invaded northern England and forced Charles to buy a truce. To do so, Charles had to recall Parliament.

The first session of the *Long Parliament* lasted from November 1640 to September 1641. Led by John Pym, it passed laws making ship money illegal and abolishing the courts of Star Chamber and High Commission. It impeached Strafford, and he was executed in 1641. The session also forced Charles to agree to call Parliament every three years, with the further provision that he could not dissolve it without its own consent.

The final crisis began with the outbreak of a rebellion of Roman Catholics in Ireland in November 1641. Charles wanted to raise a new army to reconquer Ireland, but Parliament did not trust him to command it. Instead, Parliament passed the *Grand Remonstrance*, attacking the King's policies for the past 10 years, calling for radical reform of the Church and demanding the right to control the appointment of ministers. In January 1642, Charles ordered the impeachment of five members of Parliament, including John Pym and John Hamp-

den. When Parliament refused to surrender the five, Charles invaded the Commons chamber in person—a breach of parliamentary privilege. The five had already left to take shelter in the City of London.

Surrounded by enemies in London, Charles left the capital to seek support in the provinces. In March, he refused to give up control of the army. In June, Parliament began raising its own army. It also sent Charles *Nineteen Propositions*, a document that amounted to terms for his surrender.

Charles raised his standard at Nottingham in August. The first clash had already taken place at Manchester in July. By September, fighting had broken out between *Royalists*—supporters of the King—and supporters of Parliament in all parts of the country.

Cavaliers and Roundheads

The word *Cavalier* meant a *chevalier* (horseman). It shows that the Royalists were at first superior in cavalry. The term *Roundhead* originally referred to the Parliamentary infantryman, with his hair cut short to fit his *casque* (steel helmet). By the end of the English Civil War, the armies of Parliament were superior in cavalry and infantry.

Many people imagine that the Cavaliers were all merry, dashing figures with long, flowing hair and luxurious clothes. They also think that the Roundheads were stern, pious, pleasure-hating people with close-cropped hair and dark, unadorned uniforms. A few individuals of each type certainly existed, but only as a minority on either side.

The two sides were not based on differences in class. Parliament could call on as many nobles and gentry as could the King. Many families included supporters of both sides.

Parliament's control of London and most of the other important towns gave it a distinct advantage. It raised war funds through taxation. The King had to rely on voluntary contributions. But Parliament won because it was

The English Civil War, 1642-1651



By December 1643, Charles I and his supporters controlled northern and western England and Wales. His armies had won three major battles.



By December 1645, the Scots and the forces of Parliament—especially the New Model Army under Oliver Cromwell—had taken control of most of England.



By September 1651, Cromwell had put down Royalist uprisings in Ireland and Scotland. He defeated Prince Charles at Dunbar and again at Worcester.



Officers on both sides wore armour to protect themselves, left. Infantrymen, especially in the Parliamentary armies, wore much simpler uniforms.



able to finance a professional army that could fight anywhere, any time.

The first phase, 1642-1646

The Parliamentary army assembled at Northampton in September 1642, under the Earl of Essex. Leaving Nottingham, Charles marched through Chester and Shrewsbury, recruiting an army roughly equal to Essex's. The two armies clashed at Edgehill, in Warwickshire, on October 23. The King's nephew, Prince Rupert, led the cavalry brilliantly, and the King won. But his attack on London in November failed when it reached Turnham Green. Charles pulled back to Oxford.

In 1643, the Parliamentary army under Essex spent most of the summer trying to advance on Oxford. In the north, a Royalist army under the Earl of Newcastle smashed a Parliamentary army under Ferdinando and Thomas Fairfax at Adwalton Moor, near Leeds (June 30). Then, in the west, a Royalist army under Sir Ralph Hopton defeated Sir William Waller at Roundway Down, in Somerset (July 13).

Leaders in Parliament feared that Hopton and Newcastle would join forces with Charles and attack London. They decided to turn to the Scots for help, signing the *Solemn League and Covenant* in September. The document was a *league* (treaty) against the King and a *covenant* (promise) of Church reform. The Scots crossed the border in January 1644.

The Royalist armies never joined forces. The Earl of Newcastle's army was blocked by Parliament's East Anglian forces, called the *Eastern Association*, commanded by the Earl of Manchester. Hopton's army captured Bristol, but could do no more. Charles besieged Gloucester for a time and then lost the first Battle of Newbury (Sept. 20, 1643).

In 1644, Royalist forces defeated Waller at Cropredy Bridge, near Banbury, in Oxfordshire (June 29). But, in the north, the Scots drove the Royalists under the Earl of Newcastle into York. Parliamentary forces under the Fairfaxes and the Eastern Association army, commanded by Oliver Cromwell, joined the siege. Charles ordered Prince Rupert to relieve York. On July 2, though outnumbered 3 to 2, the Royalists fought the Parliamentarians and Scots on Marston Moor. They lost the bloodiest battle of the war mainly because Cromwell defeated the Royalist cavalry under Lord Goring.

The Earl of Essex led a Parliamentary army into Cornwall, but was trapped at Lostwithiel. He escaped by boat, leaving most of his army to surrender. The Earl of Manchester marched south, but was outmanoeuvred by a much smaller Royalist army. Charles won the second Battle of Newbury (October 27).

Montrose. The chronic bad feeling between the Scots and the English led to endless disputes. The Scots moved no farther south than Newark. Then they had to send a large part of their army back north to deal with

the Marquess of Montrose. He persuaded the Highland clans to rebel against the Scottish government in the King's name in September 1644. He then conducted a brilliant guerrilla campaign, occupying Glasgow in August 1645. But he was defeated at Philiphaugh (Sept. 13, 1645). His army broke up and he fled abroad.

The New Model Army. In the winter of 1644 to 1645, Cromwell led a fierce campaign to purge the high command. Parliament passed the Self-Denying Ordinance, which required all members of both Houses to resign their commissions. The ordinance seemed designed to keep politics out of the military command. But Cromwell's friends in Parliament had him reappointed. They also persuaded Parliament to establish a full-time professional army, the New Model, under Sir Thomas Fairfax, with Cromwell as general of horse.

The New Model Army was irresistible. At the Battle of Naseby, in Northamptonshire (June 14, 1645), it destroyed the King's main field army. It then destroyed the western army under Goring at Langport, in Somerset (July 10). Rupert surrendered Bristol, and organized Royalist resistance collapsed. In April 1646, Charles left Oxford in disguise and surrendered to the Scots army at Newark (May 5). The Scots retreated with him to New-castle.

The second phase

No peace treaty was signed, because both Parliament and the Scots had always claimed that they were fighting to free the King from his wicked advisers, not fighting the King himself. They proposed constitutional safeguards to restrict the King's choice of ministers and his control of the army.

The Scots withdrew from northern England and surrendered Charles to the Parliamentarians in January 1647, in return for a large sum of money. Parliament was by then having trouble controlling the New Model Army, which objected to being demobilized without full pay and an amnesty. The army had been infiltrated by a group of extreme radicals, the *Levellers*. Led by John Lilburne, the Levellers wanted to abolish the kingship and the House of Lords and to create a republican government. They also wanted radical social reform.

Army officers kidnapped Charles in June, and in August, the army occupied London and expelled its chief opponents from Parliament. Cromwell tried to persuade Charles to accept a compromise scheme, called the *Heads of the Proposals*, which made concessions to him as well as the Levellers. But in November, Charles escaped to Carisbrooke Castle, on the Isle of Wight. There he sought help from dissident Scots nobles. War broke out again in the summer of 1648, but it was speedily over. Cromwell routed the invading Scots at Preston (August 17), and the army put down Royalist risings elsewhere.

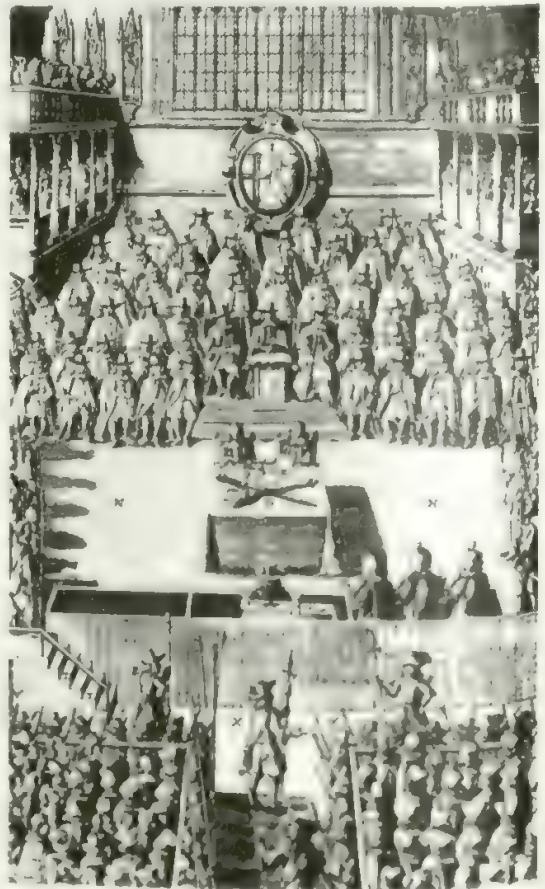
Many people held the King personally responsible for this second civil war. The victorious army demanded that he be punished. In December, it again occupied London, and Colonel Thomas Pride removed all MP's still favouring negotiations (Pride's Purge, December 6).

Charles stood trial before a special High Court of Justice in January 1649 and was convicted of high treason against the people of England and the constitution. He was executed on Jan. 30, 1649.

The Commonwealth. England became a republic, called the *Commonwealth*, and the monarchy and House of Lords were abolished. But no one moved to replace the *Rump* of the old House of Commons, which had been reduced from more than 500 to less than 150 members. The Levellers objected to the new government, but were firmly suppressed. Cromwell led the army against Ireland in 1649, finally ending the rebellion that began in 1641. His men treated the Irish with great brutality.

The Scots bitterly condemned the King's execution, pointing out that he was also King of Scotland. They recognized his son as Charles II and invited him to Edinburgh. Cromwell invaded Scotland in July 1650, and defeated the Scots at Dunbar, near Edinburgh (September 3). Montrose returned to support the young Charles, but he was defeated and executed. In the next summer, Charles II himself led the last Scots invasion of England. Cromwell defeated him at Worcester (Sept. 3, 1651). After six weeks in hiding, the King escaped to France. Scotland came under military rule, and the English Civil War ended.

The Protectorate. For all its military success, the Commonwealth could not secure the loyalty or respect of the English people. In 1653, Cromwell staged a mili-



At his trial, Charles I, shown above facing the table and members of the special court, was convicted of treason

tary coup, dissolved the Rump Parliament, and ruled as Lord Protector. His son Richard succeeded him in 1658, but fell in another coup. The leaders of this revolt quarrelled among themselves.

Finally, in January 1660, George Monk restored order. He recalled the Rump Parliament, but forced it to take back the MPs excluded in 1648. The Long Parliament promptly dissolved itself, calling for a general election in April. The new Parliament at once recalled Charles II from exile.

Results of the war

The Restoration seemed to turn the clock back to 1641. Parliament restored the Church of England and established complete religious uniformity by statute. Charles II controlled the army and appointed ministers without consulting Parliament at all. The divine right of kings was confirmed.

But despite the Restoration, Parliament—not the king—controlled the Church, and Parliament legalized religious dissent in 1689. Parliament also kept its control of taxation, won in 1641. The power and prestige of the Crown had so declined that, in 1688, Parliament was able to remove one king, James II, and substitute another, William III. The Crown's power was further limited by the Act of Settlement of 1701. This brought the Hanoverian dynasty to rule Britain and helped in the evolution of the present constitution.

Related articles. See *United Kingdom, History of*, and the following articles:

Charles II)	Laud, William
Clarendon, Earl of	Pym, John
Cromwell, Oliver	Strafford, Earl of
James II)	

Civil War, Irish, was fought between supporters and opponents of the Anglo-Irish treaty of December 1921. The war lasted from June 1922 until May 1923. Pro-treaty government forces won the war, supported by a majority of the Irish people. Their victory ensured the survival of parliamentary democracy, and removed the threat of a military dictatorship favoured by some of the anti-treaty forces. The Civil War left bitter memories, which have influenced Irish party politics ever since.

Causes of the war

In July 1921, a truce was arranged that ended more than two years of bitter warfare between British government forces and the Irish Republican Army (IRA). The British government had been ruling Ireland, and the IRA was a volunteer guerrilla force dedicated to establishing an Irish Republic. After the truce was declared, the British and Irish tried to devise a form of Irish self-government agreeable to both sides.

There were three main Irish leaders at this time. Eamon de Valera was president of Sinn Féin, the parliamentary representatives of the Republican movement. Sinn Féin had won a big majority in the general election of 1918. Arthur Griffith was vice president of Sinn Féin. Michael Collins was the IRA's most important military leader.

All three men accepted the need for compromise with the British, but they differed on the degree of compromise that they considered acceptable. A delegation headed by Griffith and Collins signed the treaty on Dec.



Civil War fighting started in Dublin. Government troops, above, outnumbered Irregulars and were better equipped. They drove the Irregulars from Dublin in about 10 days.

6, 1921, in London. De Valera chose to remain in Ireland and did not sign the treaty.

The terms of the treaty

The treaty's main terms called for British forces to withdraw from southern Ireland. The 26 southern counties were constituted the Irish Free State and given the status of a *dominion* (self-governing country) of Britain. The parliament of the six counties of Northern Ireland was entitled to withdraw from the Irish Free State and remain part of the United Kingdom, which it immediately did.

A Boundary Commission was established to determine the proper border between Northern Ireland and southern Ireland. Most Sinn Féin representatives believed that the commission would transfer so much territory to the south that the rest of Northern Ireland would not be able to survive and would have to join with the Irish Free State. Also under the treaty, Britain retained naval bases in southern Ireland, along with the right to demand further facilities in time of war.

The main cause of the Civil War was neither Ireland's *partition* (separation of north and south) nor Britain's naval bases. Instead, it was the oath of fidelity that all members of the new Free State parliament had to take to the King of England, who was head of the Commonwealth. The oath and the presence of a governor general as the king's representative in Ireland were evidence that the Free State was not the republic for which the IRA had fought.

A majority of the active IRA opposed the treaty. But *Dáil Éireann* (the Sinn Féin parliament) accepted the treaty by a vote of 64 to 57 in January 1922. A provisional government was then established with Michael Collins as chairman. Collins enjoyed the support of Griffith, but de Valera assumed the political leadership of the antitreaty minority.

Collins felt that the IRA lacked the resources to continue its fight and that the treaty could be used as a stepping stone to complete freedom. But Collins was reluctant to take arms against his old comrades. De Valera also hoped for a political solution rather than a military one. But he was quickly pushed aside by the antitreaty IRA, under Rory O'Connor, who despised civilian rule. This group seized the Four Courts building in Dublin in April.

The outbreak of war

In the general election of June 1922, antitreaty candidates won only 30 per cent of the seats. The Civil War began shortly after this election. The precise origins of the outbreak of hostilities are still uncertain. Collins came under British pressure to clear the Four Courts after the assassination of Field Marshal Sir Henry Wilson by the IRA in London on June 22. Wilson was closely associated with *Ulster Unionists* (those who wished to keep strong ties with the government of the UK) who were then engaged in bitter conflict with *nationalists* (those who desired reunion with southern Ireland) in Northern Ireland. Ironically, it may have been Collins himself who ordered the assassination. After the kidnapping of one of his senior officers on June 27, Collins immediately ordered an attack on the Four Courts.

Collins captured the Four Courts when Rory O'Connor surrendered after three days of fighting. The antitreaty forces, called the *Irregulars*, were driven from Dublin in another week. During the next month, the main provincial cities of Limerick, Waterford, and Cork were also captured by government troops. By mid-August, the Irregular forces had retreated into the small towns and the countryside, where they resorted to

guerrilla warfare. It was only a matter of time until they were crushed by the much bigger and better-equipped government army of more than 50,000 men.

On Aug. 12, 1922, Griffith died suddenly. Collins was killed in an ambush on August 22.

Collins had continued to hope for conciliation until his death. His successor as chairman of the provisional government, William Cosgrave, had little sympathy for his opponents. Cosgrave's government resorted to a policy of executing prisoners after their trial by military court. The most prominent victim of this policy was Robert Erskine Childers, publicity director for the antitreaty forces. Childers was shot in November 1922. Four senior antitreaty prisoners, including Rory O'Connor, were summarily executed on December 8 in reprisal for the assassination the previous day of a pro-treaty Member of Parliament. Historians disagree on the effects of the policy that led to the execution of 77 prisoners during the war. Some historians believe that the executions reinforced the Irregulars' will to resist. Others think that only the fear of reprisal executions prevented more widespread assassination of civilians.

The Irregulars were gradually ground down by government forces in an extended series of small-scale but bitter operations. There were atrocities on both sides. De Valera recognized the futility of the continuing struggle. But he exerted no influence over the antitreaty military leaders, many of whom despised him as a mere politician. Only when Liam Lynch, the main antitreaty commander, was killed in April 1923 did de Valera recover some of his influence over the military element. On April 27, 1923, the Irregulars announced the suspension of the conflict. There was no formal surrender by the Irregulars, only a dumping of arms to await more favourable circumstances.

Results of the war

The war's immediate result was the imprisonment of more than 10,000 Irregulars, including de Valera. Cosgrave proceeded with the historic task of state building. But his government suffered a setback in 1925 when the



The Four Courts building was held by the Irregulars before the Irish Civil War started. It was damaged early in the fighting



City streets were barricaded during the early weeks of the Civil War. Later, the war was mainly fought in country areas

Boundary Commission, contrary to nationalist expectations, recommended virtually no change in the border between Northern Ireland and southern Ireland. De Valera finally entered the Dáil in 1927 and took the oath that he had earlier denounced, regarding it as an empty formula. De Valera won the 1932 general election. Over the next six years, he abolished the oath, eliminated the office of governor general from the constitution, introduced his own new republican constitution in 1937, and, after negotiations with Neville Chamberlain in 1938, recovered the ports held as naval bases by the British.

The government's victory in the war prevented a military dictatorship from emerging. It allowed the state to be founded on a democratic tradition. However, in the long run, the real winner was de Valera. His most dangerous enemies and his most dangerous friends either died or were killed during the war. This enabled him to build later on Cosgrave's achievement. But the bitterness caused by the Civil War lasted for decades. The main division in Irish politics, between de Valera's Fianna Fáil Party and Cosgrave's Fine Gael Party, was rooted in the war and still exists today.

Related articles in *World Book* include:

Childers (Robert Erskine)	Griffith, Arthur
Collins, Michael	Ireland, History of
Cosgrave, William Thomas	Sinn Féin
De Valera, Eamon	

Civilization is a way of life that arose after people began to live in cities or in societies organized as states. The word comes from the Latin word *civis*, which means *citizen of a city*.

A civilization consists of the art, customs, technology, form of government, and everything else that makes up the way of life in a society. In this respect, civilization is similar to culture. But culture refers to any way of life and includes both simple and complex life styles. The word *civilization* refers only to life styles that feature complex economic, governmental, and social systems. Therefore, although every human being lives within a culture, not everyone lives within a civilization. See **Culture**.

Throughout history, individual civilizations have arisen and collapsed, but the basic features of civilization do not disappear. Ideas and inventions spread from one civilization to another. In many cases, similar developments occur independently in different civilizations.

How civilizations develop. During most of the prehistoric period, people lived in small groups and moved from place to place in search of food. They hunted, fished, and gathered wild plants. These early people had a simple social organization based on family ties.

About 9000 B.C., people in the Middle East began to cultivate cereal grasses and other plants. They also domesticated goats and sheep at about this time, and they later tamed cattle. In Southeast Asia, people had begun raising crops by about 7000 B.C. People living in what is now Mexico also learned to grow crops by about 7000 B.C.

The rise of agriculture was a major step in the development of civilization. Farmers settled in permanent villages, where they could grow enough food to support a few craftworkers and priests. Periodic food shortages led to increased trade among villages. The villagers exchanged grain, pottery, and various raw materials.

By about 3500 B.C., people in the Middle East had learned to smelt copper and make bronze tools and weapons. The demand for metal ore increased, and priests and chieftains gained greater control over trade. Gradually, villages in the Middle East grew into cities. Religious shrines and sacred places, which flourished as ceremonial sites, became the centres of economic and political power in the emerging cities.

Several civilizations developed independently in various parts of the world. The first one arose about 3500 B.C. in the Tigris-Euphrates Valley in the Middle East. Others developed in the Nile Valley in Egypt, the Indus Valley in what are now Pakistan and northwestern India, the Huang He Valley in China, and the Andes Mountains of present-day Peru. These ancient civilizations grew up in widely different natural environments. The people developed systems of writing and new forms of government, made advances in science and technology, and excelled in crafts and art. For a description of these and other early civilizations, see **World, History of the**.

Why civilizations rise and fall. Philosophers, historians, and archaeologists have suggested many reasons for the rise and fall of civilizations. Georg W. F. Hegel, a German philosopher of the early 1800's, compared societies to individuals who pass the torch of civilization from one to another. During this process, according to Hegel, civilization develops through three stages: (1) rule by one person, a dictator; (2) rule by one class of society; and (3) rule by all the people. Hegel believed the process eventually results in freedom for all people.

The German philosopher Oswald Spengler thought civilizations, like living things, are born, mature, and die. In *The Decline of the West* (1918-1922), he wrote that Western civilization is dying and will be replaced by a new Asian civilization.

The British historian Arnold Toynbee proposed his theory of *challenge and response* in *A Study of History* (1934-1961). Toynbee believed that civilizations arise only where the environment challenges the people, and only when the people are ready to respond to the challenge. For example, a hot, dry climate makes land unsuitable for farming and represents a challenge to people who live there. The people may respond to this challenge by building irrigation systems to improve the land. Toynbee suggested that civilizations collapse when the people lose their creativity.

Most archaeologists attribute the rise of civilizations to a combination of causes, including the structure of political and social life, the ways people modify their environment, and changes in population. In many cases, civilizations may have appeared because local chieftains took deliberate steps to strengthen their own power. Many scientists believe that political forces and the misuse of land and other natural resources resulted in the economic and political collapse of early civilizations.

For a discussion of the history of civilization, see **World, History of the**, and its list of **Related articles**. See also **City**.

Clackmannann (pop. 47,209) is a local government district in Central Region, Scotland. With the industrial town of Alloa as the seat of its administration, Clackmannann district corresponds to the former county of Clackmannanshire, once the smallest county in the United Kingdom, which was abolished in 1975. Clackmannann

50 Clacton-on-Sea

is an area of lovely scenery lying between the River Forth and the Ochil Hills.

See also **Central Region**.

Clacton-on-Sea. See **Essex**.

Claim, in its general meaning, is a legal demand. It may be one that a person asserts without basis. Or it may be one that the person is entitled to have satisfied. A claim may involve property, money damages, or any other legal right. In mining law, a claim is a piece of public land that a miner takes up for the purpose of extracting minerals. In patent law, the claim is the part of the patent application in which the applicant points out the improvement claimed as an invention.

Clair, René (1898-1981), was a French film director. In his early films, he used fantasy to poke fun at everyday life. He gained his first popular acclaim with the silent comedy *The Italian Straw Hat* (1927). When talking films arrived, Clair began directing musical comedies. He won praise for his creative use of sound in *Under the Roofs of Paris* (1929) and *A Nous la Liberté* (Give Us Liberty, 1931).

Clair was born in Paris. His real name was René-Lucien Chomette. During World War II, he worked in the United States where he directed the comedy fantasies *I Married a Witch* (1942) and *It Happened Tomorrow* (1944). He returned to France in 1946. His other films include *Le Million* (1931), *The Ghost Goes West* (1935), *And Then There Were None* (1945), and *Portes des Lilas* (Gates of Paris, 1957). In 1960, Clair became the first film maker to be elected to the French Academy.

Clairvoyance is an awareness of events, objects, or people without the use of the senses of hearing, sight, smell, taste, or touch. It is a major form of *extrasensory perception* (ESP). A person who can locate a lost child or perform similar acts without using known senses might be considered clairvoyant.

Clairvoyance supposedly is not affected by time or distance. A person may "see" an accident in a dream before it happens or sense an event taking place far away. Awareness of an event before it occurs is known as *precognitive clairvoyance*. Clairvoyance is under scientific investigation, and the question of its existence remains open. However, most scientists are sceptical. Its relationship, if any, to telepathy is not known.

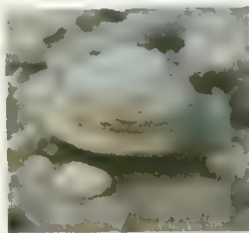
See also **Extrasensory perception**; **Mind reading**; **Telepathy**; **Parapsychology**; **Psychical research**.

Clam is an animal whose soft body is covered with a protective shell. Clams live on the bottoms of oceans, lakes, and streams in many parts of the world. They feed on tiny water organisms called *plankton*. Clams have a large organ called a *foot*, which they use to burrow in mud or sand. Their shell is made up of two parts that are called *valves*. A *ligament* fastens the valves together. The growth lines on the valves show how the shell has enlarged from time to time. The *mantle*, a fleshy part of the body just inside the shell, secretes the shell material. The space between the main body of the clam and the mantle is called the *mantle cavity*. The clam has gills that hang into the mantle cavity.

Two rear openings called *siphons* allow water filled with food and oxygen to pass into the mantle cavity through the *ventral* (lower) siphon, and out again through the *dorsal* (upper) siphon. The clam's blood circulates through the gills, takes oxygen from the water,

Some kinds of clams

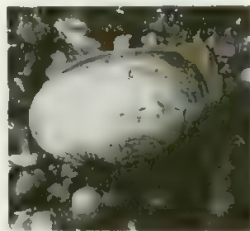
Clams live on the bottoms of oceans and other bodies of water in many areas of the world. Their shells vary greatly in size and shape. Four important kinds of clams are shown below.



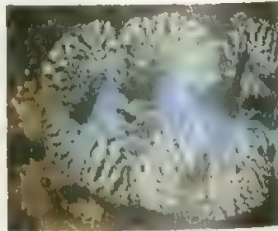
Hard-shell clam



Razor clams



Soft-shell clam



Giant clam

and gives off carbon dioxide. Tiny hairs on the gills fan the food particles to a small mouth and into the stomach. The food is digested in the stomach and passes into the intestine where most of it is absorbed. The clam has a heart and blood vessels. Other body spaces in which the blood circulates are called *sinuses*.

Clams reproduce sexually. In most species, each clam is either male or female. The male releases sperm and the female releases eggs. The sperm unite with and fertilize eggs in the surrounding water or in the gills of the female. Fertilized eggs develop into tiny free-swimming *larvae*. The larvae, also called *veligers*, eventually become mature clams. In some species of clams, the same individual produces both sperm and eggs, and the young develop inside the parent.

Clams are valuable as food. The American Indian name *quahog* is sometimes given to the hard-shell clam. This clam was used as *wampum* (money) by the American Indians. It is a saltwater clam and is found in mud and sand along North Atlantic coasts.

Soft-shell clams have a smooth, thin shell. They are also found on tidal flats in the North Atlantic region. These clams burrow into the sand and have long siphons that extend above the sand into the water. People take great numbers of these popular food clams from the mud flats of New England.

Giant clams live on coral reefs in the East Indies and off Australia. Their shells may weigh over 230 kilograms and may be over 1 metre long. They feed on microscopic seaweeds.

Scientific classification. Clams belong to the phylum Mollusca. They are members of the class Bivalvia. Hard-shell clams belong to the family Veneridae, soft-shell clams are in the family Myidae, and giant clams belong to the family Tridacnidae.

See also **Geoduck**; **Mollusc**; **Wampum**.

Clan is a group of people who are related through a common ancestor. Some clans are *matrilineal* (related through the female line). Others are *patrilineal* (related through the male line). Although they may live far apart, members of a clan can feel a close relationship to each other, and usually have a strong spirit of unity. They often share property or special privileges. Most clans are *exogamous*. That is, the members must marry outside the clan. Clans are often named after a *totem* (a symbolic animal or plant). American Indian tribes had clans such as the Bear clan or Tobacco clan.

The word *clan* also refers to groups of people in early Scotland and Ireland who had common ancestors and a common name, and were organized under the rule of a chief. These clans were *bilateral* (related through both men and women), and marriage within the clan was customary. The Scottish clans began about A.D. 1000. They carried on feuds in the Highlands, and clan members were expected to defend one another. Most clans lost power after the rebellion of 1745, but a spirit of clan loyalty remains among some Scots. They are distinguished by their names—such as MacDonald and Campbell—and by their *tartans*, the plaids worn as emblems of clan membership (see *Tartan*).

Clare is a county on the west coast of the Republic of Ireland, in the province of Munster. It is known as the *Banner County* because of the many political leaders who have been associated with it. Clare is popular with tourists.

The new town of Shannon has been a major growth area in the west of Ireland. Many people commute to work in Shannon Airport, or the neighbouring industrial estates. Clare's largest town is Ennis.

People and government. The population of Clare has recently increased at a greater rate than that of any other Irish county, apart from those near Dublin. Clare's population has been increasing since the mid-1960's, but growth was greatest in the 1970's. Growth is concentrated in the Ennis, Shannon, and Limerick areas. Two-thirds of the population live in the rural areas.

The population of Clare is 96 per cent Roman Catholic. The Church of Ireland is the second most popular



Bunratty Castle, in County Clare, is a massive rectangular keep built in the 1400's. It is now famous for its medieval banquets.

denomination. For both churches, most of the county is in Killaloe diocese. A Roman Catholic cathedral is in Ennis and a Church of Ireland cathedral is in Killaloe.

Clare forms a separate constituency which is represented by four members of parliament in *Dáil Éireann* (lower house of parliament). Local government is by a county council based in Ennis. Ennis and Kilrush have urban district councils.

Economy. About 25 per cent of Clare's people work in agriculture. Farms average 20 hectares in area, larger than in the other west coast Irish counties. Cattle rearing and dairy farming are the main activities. Milk is sent to creameries for processing and most of the cattle are moved to farms in the east for fattening. Farmers raise sheep in northern and upland areas, and some farmers raise horses. Farmland is almost entirely pasture, and only 1 per cent of the agricultural land grows arable crops. There is forestry in the upland districts of eastern and western Clare.

Manufacturing industry accounts for over one-fifth of employment. About half of the output is light engineering, including electronics. Chemicals are also important. The major centre of manufacturing is the Shannon industrial estate. It was established in the 1950's as a means of increasing business at the adjacent airport. A large number of light industries have moved there. Ennis is the other main centre. There is a factory making compressed timber products at Scariff.

Ireland's largest power station is at Moneypoint on the estuary of the River Shannon. It burns imported coal. The country's first and largest river hydroelectric plant uses the water of the Shannon at Ardnacrusha.

About 45 per cent of the county's population work in service industries. Retailing, transport, education, health, and administration are important. Tourism is also



Clare is a county on the west coast of the Republic of Ireland. It is one of six counties in the province of Munster.

Facts in brief about Clare

Population: 1991 census—90,826.

Area: 3,188 km².

Largest towns: Ennis, Shannon, Kilrush, Newmarket-on-Fergus, Kilkee.

Chief products: Agriculture—cattle, milk. Other primary products—building material, fish, timber. Manufacturing—chemicals, chipboard, electronic equipment, food products, instruments and tools, lenses, printed materials, textiles.

Origin of name: From the Irish *An Clár* (the plain).

a major industry. Medieval banquets in castles such as Bunratty are a popular attraction. Thatched Irish cottages for rental were first widely developed in Clare. Lisdoonvarna is Ireland's only spa town and has a popular festival in September.

The major transport route is the national primary N18 road northward from Limerick through Ennis to Galway. The national secondary N67 serves the west of the county and is joined to Ennis by the N68. The railway carries only freight traffic and follows a route similar to the N18. The international Shannon Airport is the country's second busiest airport and is mainly for transatlantic traffic. It has the world's first duty-free shop. Irish coffee was invented there. A car ferry crosses the Shannon estuary from Killimer to Tarbert in Kerry.

Land. Clare is a peninsula, with water on three sides. It is bounded on the west by the Atlantic Ocean, on the south by the Shannon estuary, and to the north by Galway Bay. The River Shannon and Lough Derg separate it from Limerick and Tipperary in the east. Clare's longest dimension is 120 kilometres from the northeast to Loop Head in the southwest. The county measures 75 kilometres from east to west.

In the east of Clare, the Slieve Aughty and Slieve Bernagh mountains are formed of slate, shale, and sandstone. These uplands rise to a height of 530 metres. Beneath them lies the picturesque Lough Derg on the River Shannon, where pleasure boating is popular.

The lowland centre of the county lies on limestone. There are many lakes on its surface. Some of these are *turloughs* (lakes which dry up in the summer). The River Fergus drains much of Clare and runs into the Shannon estuary.

The land rises to a low plateau in west Clare. In the north lies the unique Burren area of barren limestone landscapes. The Ailwee Caves are open to the public. There is no surface water in the Burren. But the remainder of west Clare has a damp landscape, with many rushes and peat bogs on top of shales and sandstones. These rocks end on the west coast in the spectacular Cliffs of Moher, which have a sheer drop of 200 metres into the Atlantic Ocean. There are also beaches on this coast at the resorts of Lahinch and Kilkee.

The yearly rainfall is 100 to 120 centimetres over most of Clare, but is higher in the uplands. Rain falls on more than 170 days a year. The average temperature in January is 6° C. The July average is 15° C.

History. Clare is rich in stone monuments and *raths* (fortified farm enclosures) from prehistoric and early historic times. There are remains of many Celtic and medieval monasteries, and also castles and tower houses. Clare was a zone of conflict between Munster and Connacht in Celtic times. Brian Boru lived near Killaloe and became High-King of Ireland. He was killed when defeating the Danes at the Battle of Clontarf near Dublin in 1014. After this, the power of the O'Briens, Brian Boru's descendants, was confined to the north Munster kingdom of Thomond, which included Clare. The O'Briens remained in control of Clare until the 1600s. After the Cromwellian wars, as part of Connacht, it was a refuge for Irish who had lost land elsewhere in the country. The county suffered severely in the famine of the 1840s. National leaders first elected to parliamentary office in Clare include the Catholic liberator, Daniel O'Connell, in

1828, and Eamon de Valera, prime minister and president, in 1917. A summer school is held to commemorate the Clare poet Brian Merriman.

Related articles in *World Book* include:

De Valera, Eamon
Ireland
Ireland, History of

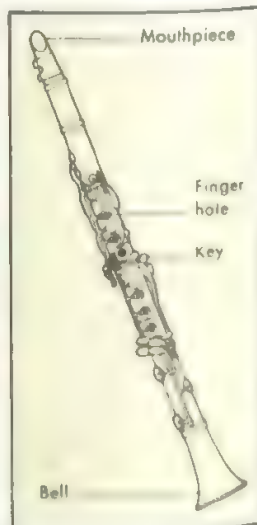
Munster
O'Connell, Daniel
Shannon, River

Clarence, Duke of. See *Kings and queens of Britain and Ireland* (The Houses of Saxe-Coburg and Windsor). **Clarendon, Earl of** (1609-1674), played a leading part in restoring the monarchy in England in 1660. Clarendon originally sided with Parliament in its dispute with King Charles I, who tried to keep all political power for himself. But when civil war broke out in 1642, Clarendon joined the *Royalists* (supporters of the king). He insisted that the king represented the entire kingdom, not just a royal group. Named lord chancellor in 1660, he tried to restore England to, in his words, "its old good manners, its old good humour, and its old good nature." But he was forced into exile in 1667. In exile he wrote the 10-volume *History of the Rebellion*, which defends the Royalist activities during the civil war. Clarendon was born Edward Hyde in Dinton, Wiltshire, England. He studied at Oxford University.

Clarendon Code was a series of four Acts of Parliament aimed at enforcing religious conformity with the Church of England. The Acts were the Corporation Act, the Act of Uniformity, the Conventicle Act, and the Five Mile Act. The Code promoted the persecution of Roman Catholics as well as the suppression of extreme Protestants. The laws were passed between 1661 and 1665, during the reign of Charles II. They were named after the Earl of Clarendon, though he did not originate the legislation.

See also *Clarendon, Earl of; United Kingdom, History of the* (The Restoration).

Clarinet is a woodwind instrument. Most clarinets are made of wood. The instrument consists of a tube with a



The clarinet is a popular woodwind instrument. A musician blows through the mouthpiece and produces different notes by pressing keys and covering or uncovering finger holes.

mouthpiece at one end and a bell-shaped opening at the other. A clarinet has open *finger holes* and other holes covered by small metal levers called *keys*. The musician places his or her fingertips on the holes and keys and blows on a flat cane reed attached to the mouthpiece. The reed vibrates, producing a full, rich tone. The musician plays different notes by covering or uncovering various holes. Clarinets are manufactured in five pitches. The B-flat soprano clarinet is the most popular.

Johann Christoph Denner, a German instrument maker, invented the clarinet about 1700. It has been an important instrument in bands and orchestras since the mid-1700's.

See also **Music** (pictures: Wind instruments).

Clark, Lord (1903-1983), was a British writer on art who won fame with such books as *The Gothic Revival* (1929), *Leonardo da Vinci* (1939), *The Nude* (1955), and *Ruskin Today* (1964). He became widely known with his television series, *Civilization*. Kenneth Mackenzie Clark was born in London. He was educated at Winchester and Trinity College, Oxford. He was keeper of the Department of Fine Art at the Ashmolean Museum, Oxford (1931-1933), director of the National Gallery in London (1934-1945), and Slade Professor of Fine Art at Oxford (1946-1950 and 1961-1962). He was also chairman of the Arts Council of Great Britain (1953-1960).

Clark, Charles Joseph (1939-), was prime minister of Canada from June 1979 to March 1980. Clark was the youngest prime minister in the history of Canada. He was only 39 years old when he took office in 1979, after leading the Progressive Conservative Party to its first national victory since 1962. But opposition to Clark's government soon became widespread, and his own popularity fell rapidly. Clark called a general election for February 1980, and the Liberal Party returned to power.

Joe Clark was born on June 5, 1939, in High River, Alberta. He was educated at the University of Alberta. Clark was first elected to the House of Commons in 1972. He was leader of the Progressive Conservative Party from 1976 to 1983, when he was succeeded by Brian Mulroney.

Clark, Charles Manning Hope (1915-1991), an Australian historian, was professor of history at the Australian National University from 1949 to 1975. His best-known works include *Select Documents in Australian History 1788-1850* (1950), *Settlers and Convicts* (1953), *Select Documents in Australian History 1851-1900* (1955), and *Sources of Australian History* (1957). The first volume of his major six-volume work, *A History of Australia*, was published in 1962. He was born in Sydney.

Clark, George Rogers (1752-1818), was an American frontiersman and soldier who won important victories in the Northwest Territory during the American Revolution (1775-1783). The Northwest Territory was a vast tract of land lying north of the Ohio River, south of Canada, west of Pennsylvania, and east of the Mississippi River. Clark's victories helped the American negotiators claim this area during peace talks with Great Britain which ended the Revolutionary War.

Clark was born near Charlottesville, Virginia, U.S.A. He became a surveyor as a young man and began exploring and surveying the western frontier. When the American Revolution broke out, Clark was living in Kentucky. Although this region was claimed by the Colony



The Fall of Fort Sackville, detail of an oil painting by Frederick C. Yohn, William Henry Smith Memorial Library, Indiana Historical Society, Indianapolis, U.S.A.

George Rogers Clark captured Vincennes in 1779 by forcing the British to surrender the fort that controlled the town.

of Virginia, the Virginia colonial government at first refused to send military aid to protect the Kentucky settlers from raids by the Indian allies of the British. In response, Clark argued, "if a country is not worth protecting, it is not worth claiming." Virginia officials yielded. They sent valuable supplies of gunpowder to the settlers.

In 1777, Clark convinced the governor of Virginia that the British were supplying weapons to the Indians to fight the Kentuckians. Great Britain sought to control all the region west of the Appalachian Mountains. Clark was commissioned a lieutenant colonel in the Virginia militia and brought together about 175 men to carry the fight into the Northwest Territory. In 1778 and 1779, he and his men captured three key settlements in the region. In 1783, Britain formally surrendered the region to the United States.

In 1783, Clark was asked to explore the land west of the Mississippi River. But Clark refused. His younger brother, William, agreed to take part in a similar project in 1803 and became a leader of the Lewis and Clark expedition. See **Clark, William**.

Clark, Jim (1936-1968), became one of the world's greatest motor-racing drivers. Clark won 25 Grand Prix races. Grand Prix races are road races held in many countries in which points are awarded to the top drivers. Clark won world racing titles in 1963 and 1965 by earning the most points in Grand Prix races. In 1963, he became the youngest driver ever to win the world title. He won the 1965 Indianapolis 500-mile race. Clark was born in Fife, Scotland. He was killed in a race in Hockenheim, Germany.

Clark, Mavis Thorpe (1924-), is the pen name of Mavis Latham, an outstanding Australian children's novelist. Most of her books are pioneering stories about the difficulties faced by settlers in Australia. Character handling is sympathetic and full of human interest. Her best-known work, *The Min-Min*, won the Children's Book Council of Australia Award in 1967. *Blue Above the Trees*, about a Gippsland family's efforts to win a farm from the rainforest, won a commendation in 1968.

Clark, William (1770-1838), was an American soldier and explorer. He and Meriwether Lewis led an expedition that explored from the Louisiana Territory to the Pacific Coast from 1804 to 1806. The group started up the Missouri River in May 1804. By boat, on horseback, and on foot, the men pushed north and west until they reached the Pacific Ocean. On the return trip, Clark explored the Yellowstone River to its mouth.

Before this expedition, Clark served in several campaigns against the Indians. In 1792, he became a lieutenant in the regular army and served under General Anthony Wayne. Clark resigned from the army in 1796, but joined it again in 1803 to go west with Lewis. Clark recruited and trained men for the hazardous trip. He mapped routes covered by the expedition and made sketches of the animal life along the way. Clark also assembled records of the journey and helped prepare them for publication.

Clark was born in Caroline County, Virginia. His brother was George Rogers Clark, a Revolutionary War hero. In 1807, William Clark became superintendent of Indian affairs at St. Louis, Missouri, and in 1813 he became governor of the Missouri Territory. Clark's involvement in Indian affairs continued until his death.

See also **Clark, George Rogers**; **Lewis, Meriwether**; **Lewis and Clark expedition**; **Sacagawea**.

Clarke was the name of Australia's last bushranging gang. The gang consisted chiefly of two brothers—**Thomas Clarke** (1840?-1867) and **John Clarke** (1846?-1867). In 1865, Thomas escaped from Braidwood Jail in New South Wales, where he had been imprisoned for assault and robbery. During the next two years, he was responsible for 9 mail robberies, 36 other thefts, and the death of a policeman. In May 1866, John joined Thomas, and they went on a rampage of crime. They were helped by uncles and local residents who shared the loot or feared reprisals. On April 27, 1867, a strong force of police arrested the Clarke brothers in a settler's hut at Braidwood. The two brothers were hanged on June 25, 1867.

Clarke, Sir Andrew (1824-1902), a noted Australian administrator, became surveyor general of Victoria in 1853. As a minister in the colony's first government, he introduced measures to establish local bodies and to expand the railways. He was born at Southsea, Hampshire, England, and sailed to Australia in 1846.

Clarke, Arthur C. (1917-), is a British-born author of science fiction and related nonfiction. His novels are noted for their blend of scientific accuracy and spiritual optimism, and many of them describe the exploration of other worlds. The novels include *Childhood's End* (1953), his finest single work; *The City and the Stars* (1956); *Rendezvous with Rama* (1973); and *The Fountains of Paradise* (1979). With film director Stanley Kubrick, Clarke wrote the screenplay for the film *2001: A Space Odyssey* (1968). He continued the series with the novels *2010: Odyssey Two* (1982) and *2061: Odyssey Three* (1988). Excellent examples of his short fiction were collected in *The Other Side of the Sky* (1958).

Arthur Charles Clarke was born in Somerset, England, and settled in Ceylon (now Sri Lanka) in the mid-1950's. He was the first person to propose communications satellites. Clarke's book *The Exploration of Space* (1951) helped make the idea of space travel popular in the

1950's. His nonfiction works include *Interplanetary Flight* (1950), *The Challenge of the Sea* (1960), *Profiles of the Future* (1962), and *The View from Serendip* (1977).

Clarke, Austin (1896-1974), was a noted Irish poet. His poems are intensely personal and deal with Irish social and cultural issues. His books include *Collected Poems* (1936), *Collected Later Poems* (1961), and a book of memoirs, *Twice Round the Black Church* (1962). Clarke was born and educated in Dublin.

Clarke, Jeremiah (1669?-1707), was a British composer and organist. He is remembered for his "Trumpet Voluntary," which was once thought to be by Henry Purcell. Clarke composed church and theatre music. His birthplace was probably Windsor, Berkshire.

Clarke, Marcus Andrew Hislop (1846-1881), was a novelist and journalist who wrote the Australian classic *For the Term of His Natural Life*. Originally called *His Natural Life*, the book is a vigorous social protest about the sufferings of convicts in early Tasmania. Clarke originally wrote the story in serial form for the *Australian Journal*. It was published as a book in 1874.

Clarke was born in London, the son of an Irish lawyer. He moved to Australia when he was 17 years old. He worked in the Bank of Australasia and as a secretary and on a sheep station. But he hated routine employment and soon left these positions. He became a successful journalist, writing for and editing several magazines, including the *Colonial Monthly*.

Clarke, Ron (1937-), an Australian athlete, established himself during the mid-1960's as one of the greatest long-distance runners in history. During a tour of the United States and Europe in 1965, he became the first man in the world to run 3 miles (5 kilometres) in less than 13 minutes. He broke 11 other world records in 16 races. He set records in 5,000 metres, 10,000 metres, 6 miles (10 kilometres), and 20,000 metres.

Clarke was born in Melbourne. He set a junior world mile (1.6 kilometres) record in 1956, but withdrew from running to devote more time to his career as an accountant. He returned to important contests in 1962. Clarke won the bronze medal in the 10,000 metres at the Olympic Games in 1964. He retired from athletics in 1970.

Class, in biology. See **Classification**, Scientific.

Class, Social. See **Social class**.

Class action is a type of judicial proceeding in which one or more individuals sue on behalf of a group having similar claims. Such a group is called a *class*. Class action is also called *representative action*. Suppose that many consumers had to pay an unreasonably high price for a product because its few producers agreed illegally to charge similar prices. Most purchasers could not afford an individual lawsuit to recover the overcharge. But they might pool their claims and file a class suit to collect damages from the companies.

People first used class suits to recover money owed to them in bankruptcy cases. During the 1950's and 1960's, civil rights groups in the United States used class action to fight school segregation, job discrimination, and housing and voting restrictions. Since the 1960's, the use of class actions has expanded to all types of consumer actions, including price fixing. Environmental protection groups also have filed class actions to protest against oil spills and other public nuisances.



A performance of classical music in a concert hall features highly skilled musicians. Many classical music concerts involve both instrumental music and singing. The design of a modern auditorium, like the one above, enables audiences to listen to music in excellent conditions.

Classical music

Classical music is music written chiefly for concerts, for religious services, and for opera and ballet. It includes music for groups of instruments—such as symphony orchestras—for voices, and for both instruments and voices. Classical music is sometimes called *art music*. Most classical music is more complex than *popular music*, which includes country music, folk music, rock music, and jazz.

Classical music varies greatly. Many compositions are extremely long and have a variety of *tempos* (speeds) and styles. Others are short and have the same tempo and style throughout. Some classical music deals with a specific subject. For example, it may tell a story, express an idea, or describe a mood.

There are two principal kinds of classical music. These two kinds are *instrumental music* and *vocal music*. Composers write instrumental music to be performed by one instrument, a small *ensemble* (group of instruments), or an orchestra. Vocal music may be written for one singer, for several singers, or for a large chorus. Many works of classical music combine both instrumental parts and vocal parts.

Most performances of classical music feature highly skilled and extensively trained musicians. A conductor directs performances that involve an orchestra or chorus. The conductor selects the music, rehearses it with the musicians, and guides them in its performance.

The beginnings of Western classical music date from ancient times. Certain styles, forms, and principles of composition became popular during different periods of history. The spread of Christianity played an important part in the early growth of Western classical music. Many forms of classical music were created to be performed during church services. Later, royalty and wealthy nobles promoted the advancement of classical music by encouraging composers to produce particular types of music. At the beginning of the 1800's, composers such as the German Ludwig van Beethoven began to write music that was designed neither for church services nor for the entertainment of the nobility. Composers started to express their own thoughts and emotions through classical music.

This article deals with the major forms and styles of Western classical music. It also traces the history of Western classical music. To read about other kinds of Western music, see such *World Book* articles as *Country music*, *jazz*, and *Popular music*. For information on

the music of non-Western cultures and the basic elements of music, see **Music**.

Instrumental music

There are three main kinds of instrumental music: (1) solo, (2) chamber, and (3) orchestral. They differ chiefly according to the number of musicians who perform the music. Solo music is played by only one musician. A small group of musicians—in most cases, from 2 to 5—performs chamber music. A large group—as many as 100 musicians or more—plays orchestral music.

Solo music can be composed for any instrument, but much of it has been written for the piano. This instrument enables a musician to play more than one melody at a time and to give the music richness and depth. The organ and the harpsichord are also used. Solo music written for the cello, clarinet, flute, French horn, guitar, harp, oboe, trumpet, viola, and violin often includes accompaniment by a keyboard instrument.

A long solo composition may consist of a number of sections, called *movements*. The most common form of long composition is the *sonata*. The movements of a sonata vary in speed and style. Many sonatas have a fast first movement, a slow second movement, a dancelike third movement, and a vigorous fourth movement. The rousing final movement is called the *finale*. Some of the best-known piano sonatas were written by Ludwig van Beethoven of Germany and Wolfgang Amadeus Mozart of Austria. Johann Sebastian Bach of Germany composed well-known sonatas for the violin and the cello.

The most common short type of solo music is the *character piece*, a simple, lyrical composition that expresses a certain characteristic. The characteristic may be a mood, a thought, or an emotion.

A type of solo music composed chiefly for keyboard instruments is called the *prelude and fugue*. The *toccata* is a form of solo composition written primarily for the organ. The *chorale-prelude*, another important type of organ solo, once preceded the singing of a hymn.

Chamber music is chiefly written for 2 to 5 musicians. But music for as many as 20 players may also be called chamber music. In most chamber music, each musician plays a different part. Chamber music was originally performed in the chambers, or rooms, of private homes, rather than in churches or public halls.

Almost all chamber music is composed for one of several types of ensembles. These groups include the *string trio* (violin, viola, and cello); the *piano trio* (piano, violin, and cello); the *string quartet* (two violins, viola, and cello); the *string quintet* (two violins, two violas, and cello); or two violins, viola, and two cellos; and the *piano quintet* (piano, two violins, viola, and cello). Ensembles of six or more musicians vary in makeup.

Most chamber music consists of four movements. Compositions are named according to the instruments involved, such as a string quartet or a piano quintet.

Orchestral music is written to be performed for large audiences. The size of an orchestra ranges from about 15 to more than 100 musicians. The musicians are organized into groups, called *sections*, according to the instruments they play.

An orchestra has four main sections. They are (1) string, (2) woodwind, (3) brass, and (4) percussion. The string section of an orchestra consists of violins, violas,



A string quartet has two violinists, a viola player, and a cello player. It is one of the most common chamber music groups. Music written for such a group is also called a string quartet.

cellos, and double basses. The woodwind section includes flutes, oboes, clarinets, and bassoons. An orchestra's brass section consists of such instruments as trumpets, French horns, and trombones. The percussion section includes bells, cymbals, and various kinds of drums. The string, woodwind, and brass sections of most orchestras have two or more musicians who play the same kind of instrument and the same part.

The chief forms of orchestral music are *symphonies*, *concertos*, *suites*, and *symphonic poems*. Most symphonies consist of three or four movements that follow the structure of the sonata. Symphonies express a variety of ideas and emotions. For example, the German composer Robert Schumann dealt with his happiness at being married in his symphony *Spring* (1841).

A concerto highlights a particular instrument, such as the piano or violin. Composers have written concertos for nearly every instrument. Most concertos have three movements, of which the first and third are fast and the second is slow. A type of concerto called a *concerto grosso* features more than one instrument. The Italian composer Antonio Vivaldi wrote many such concertos, chiefly for stringed instruments.

During the 1700s, a suite consisted chiefly of a collection of dances. But in the 1800s, it began to include a series of contrasting movements. Well-known suites include the *Peer Gynt Suite* (1876) by the Norwegian composer Edvard Grieg and the *Nutcracker Suite* (1892) by Peter Ilich Tchaikovsky of Russia. A suite may consist of various pieces of music written for certain parts of a play. Such a suite is known as *incidental music*.

A symphonic poem expresses the theme of a story or some other literary work. The form of the model determines how the composer organizes the music. Tchaikovsky based his symphonic poem *Romeo and Juliet* (1870) on William Shakespeare's famous play.

Some orchestral music, including the *overture*, has only one movement. Such a composition may serve as the introduction to an opera or a play.

Vocal music

There are four chief types of vocal music: (1) songs, (2) choral music, (3) operas, and (4) oratorios.

Songs are compositions for vocal soloists. In classical music, the works are sometimes known as *art songs*. Many song composers select a poem of literary merit and set the words to music. The music strengthens and emphasizes the meaning of the words. Originally, most singers performed without accompaniment. Today, the majority of singers are accompanied by a pianist. A chamber ensemble or an orchestra may also provide the accompaniment.

The best-known songs are the *lieder* written by German composers during the late 1700's and the 1800's. *Lieder* is a German word for *songs*. Most *lieder* have a piano accompaniment and are set to a romantic poem. For example, Franz Schubert based his song "Gretchen at the Spinning Wheel" (1814) on a love poem by Johann Wolfgang von Goethe. Schubert probably ranks as the most noted composer of *lieder*. Other composers known for their *lieder* include Johannes Brahms, Robert Schumann, and Hugo Wolf.

A song may be short or long, simple or complex. The melody may be repeated throughout the composition, or it may follow no pattern at all. Some composers write *song cycles*. Such works are sets of songs about the same subject.

Songs called *part songs* are written for two or more performers. Each singer has a different part, or two or more performers sing each part. Most such songs written before 1600 have parts for four to six singers and are sung a *cappella* (without accompaniment). The majority of part songs by later composers have a piano accompaniment. Sacred part songs, called *motets* or *anthems*, are based on religious texts and are performed during church services. The most important type of nonreligious part song is the *madrigal* (see *Madrigal*).

Choral music is written for a chorus. Most choral music written since the 1400's has parts for four voices—soprano, alto, tenor, and bass. A chorus may sing a *cappella* or with accompaniment by an orchestra, a chamber ensemble, an organist, or a pianist. Operas, symphonies, and other musical productions may feature choral music. For example, Beethoven's famous ninth symphony includes a chorus.

Most choral music has been written for religious services. The principal form of such choral music is the

mass, a series of pieces composed for the Roman Catholic Mass. In the 1560's, the Italian composer Giovanni Palestrina wrote *Mass of Pope Marcellus II*, which became a model for masses. Palestrina wrote this composition for a small, unaccompanied chorus. Later composers, including Bach, Beethoven, and Schubert, wrote masses with parts for vocal soloists and orchestral accompaniment. The *requiem*, which is a mass composed for funerals, also involves choral singing. Important requiems were written by such composers as Mozart, Hector Berlioz of France, and Giuseppe Verdi of Italy.

Operas combine drama with vocal and instrumental music. The music, which is set to the *libretto* (text) of an opera, highlights the dramatic or comic aspects of the story. Many operas involve an orchestra, vocal soloists, a chorus, and ballet. The greatest opera composers include Mozart, Verdi, Claudio Monteverdi and Giacomo Puccini of Italy, and Richard Strauss and Richard Wagner of Germany.

The most important kinds of vocal music in opera are *recitatives* and *arias*. Recitatives, which performers sing in a simple, speechlike style, carry the action of the opera forward by giving the audience information about the characters or plot. Arias are vocal solos with much more complex melodies than those of recitatives. These solos express the feelings and thoughts of characters in an opera. See *Opera* (Recitative and arias).

Most operas consist of a series of arias, duets, and choruses connected by recitatives. Such operas are known as *number operas*. Other operas, called *music dramas*, have no breaks between episodes or scenes. Wagner developed this kind of opera in the 1800's.

Oratorios, like operas, use an orchestra, vocal soloists, and a chorus to tell a story. However, an oratorio has no stage action. Most oratorios have a religious subject. Famous religious oratorios include *Messiah* (1742) and *Judas Maccabaeus* (1747) by the German-born composer George Frideric Handel, *The Creation* (1798) by Joseph Haydn of Austria, and *Elijah* (1846) by Felix Mendelssohn of Germany. Among the most important nonreligious oratorios are Haydn's *The Seasons* (1801) and *Joan of Arc at the Stake* (1935) by the French composer Arthur Honegger.

A short oratorio is called a *cantata*. Most cantatas



Choral singing plays an important part in many works of classical music. At the left, the audience joins in singing the *Messiah*, a famous oratorio by the German-born composer George Frideric Handel. This work also has parts for vocal soloists and orchestral accompaniment.

are composed for church services. Bach wrote more than 200 cantatas, most of them based on hymns.

Classical music forms

Composers of classical music give form to their works by using three main techniques—*repetition*, *variation*, and *contrast*. A composer develops a *theme* (main melody) for a work and repeats it throughout. At times, the composer varies the theme slightly or uses a completely new melody to provide contrast with the theme.

The most important patterns involving repetition, variation, and contrast include (1) simple forms, (2) the sonata form, (3) the variation form, and (4) fugue. Some pieces of classical music have no pattern of repetition, variation, and contrast. They are written in *free form*.

Simple forms include the *binary form* and the *ternary form*. Music written in the binary form has two parts. Suppose that *A* represents the theme of a piece, *A'* a variation of the theme, and *B* a contrasting section. The two parts of a composition in the binary form would have a sequence of *AA'* or *AB*. Many composers of the 1600's and 1700's used binary form in minuets and other music written for dancing.

The ternary form, also known as *song form*, consists of three parts. This form has a *reverting* pattern—that is, the composer repeats the theme or a variation of it after a contrasting part. The three parts have a sequence of *ABA* or *ABA'*. Many songs have the ternary form. The dancelike third movements of sonatas, concertos, and symphonies also have this form.

Composers sometimes create a more elaborate pattern from the ternary form by adding more contrasting parts. Such a pattern is called a *rondo*. The sequence of parts in a typical rondo is *ABACABA*, with *B* and *C* representing the new contrasting sections.

The sonata form, also known as the *sonata structure*, developed in western Europe during the mid-1700's. The sonata form received its name because composers used it for the movements of sonatas. The sonata form was the most common musical form from the late 1700's to the mid-1900's. Composers used it not only for sonatas but also for the first movements of string quartets, symphonies, and other instrumental compositions. Beethoven, Haydn, and Mozart became famous for their work with this form.

A movement in the sonata form has three parts. The first part, called the *exposition*, introduces the main theme or group of themes. In the second part, the *development*, the composer varies the themes, combines them, breaks them into smaller sections, or plays them in different keys. The third part of the movement, the *recapitulation*, restates the original theme or themes.

The composer may give the movement an *Introduction* and a concluding section called the *coda*. The introduction comes before the exposition. The coda follows the recapitulation.

The variation form, also known as the *theme and variation form*, consists of a theme and a series of different versions of it. Each of these versions is known as a variation. Composers use this form throughout a composition or in a movement of a work. A variation may be based on the entire theme, on a certain part of it, or on its accompaniment. Some variations also involve a change of key or of rhythm.

Fugue is a form of musical composition in which several instruments or singers repeat a series of melodies with slight variations. Generally, however, the word *fugue* refers to a work written in this form. The fugue is the chief type of music with *counterpoint*, a combination of two or more melodies. Bach composed the most famous fugues.

Many fugues have been written with four parts, called *voices*. A fugue begins with the first voice presenting the basic melody, called the *subject*. The second voice then gives the *answer*, a melody that is very similar to the subject but at a higher or lower pitch. During the answer, the first voice may present a second subject, known as the *countersubject*. Next, the third voice joins the first two voices with a restatement of the subject. The fourth voice completes the group by repeating the answer. A fugue contains passages called *expositions*, in which each voice states the original subject. In most cases, the expositions in a fugue are linked by brief sections called *episodes*. An episode does not include statements of the subject in all parts.

Free form gives the composer the greatest freedom of all. A composition written in free form has no standard pattern of theme, variation, and contrast. Each section of a free-form composition is completely different. The composer gives the work a sense of unity by means of the harmony and orchestration used. Instrumental compositions in free form include *fantasias*, *improvisations*, and *rhapsodies*. Many symphonic poems also have this form. The French composer Claude Debussy used free form in *Jeux* (*Games*, 1912), an orchestral piece for ballet.

History

Beginnings. Scholars know little about the music of the earliest civilizations. Musicians and their instruments appear in many ancient works of art. However, early people did not write down music, and so we know almost nothing about how it sounded.

The music of the Greeks was the most influential music of ancient times. The systems of music theory that the Greeks worked out helped shape the development of later Western music. To the Greeks, the word *music* had a much broader meaning than it does today. For example, it included poetry.

According to Greek mythology, the gods invented music. The ancient Greeks associated certain music with certain gods. Such Greek philosophers as Plato and Aristotle believed that music had emotional qualities and influenced human behaviour. They thought that people who listened to a certain type of music acquired the qualities associated with it. For example, a slow, steady style of music played on a type of lyre called the *cithara* was believed to have a calming effect. The Greeks associated such music with Apollo, the god of light, purity, reason, and the sun. A passionate style of music played on the *aulos*, a wind instrument, was associated with Dionysus, the god of wine. This music supposedly caused wild, unpredictable behaviour.

Music had an important role in many Greek public events, especially dramas, athletic competitions, and religious ceremonies. All Greek music, both instrumental and vocal, was probably *monophonic*—that is, it consisted of a single melody throughout. The Greeks

based their music on scales called *modes*, which resembled the major and minor scales used today.

The ancient Romans continued the musical theories and performing techniques of the Greeks. In addition, the Romans developed such instruments as the trumpet and pipe organ.

The Middle Ages. From the A.D. 400's to the 1500's, music became much more structured and complicated. The oldest known Christian music was *plain song*, used in church services. This vocal music developed gradually from early Jewish religious music. Much plain song was set to the words of *psalms*, lyrical poems from the Old Testament. A soloist or choir sang the melody without accompaniment. The most important type of plain song was the *Gregorian chant*, developed during the reign of Pope Gregory I, who died in 604.

Music remained monophonic until about 800. Composers in western Europe then began to create *polyphonic* music by putting two or more melodies together. The earliest form of this music, known as *organum*, was created by adding a new part to an existing piece of plain song. At about the same time, a means of writing down notes of different lengths was developed.

Beginning about 900, more *secular* (nonreligious) songs began to appear. During the 1100's and 1200's, French nobles composed many secular songs and poems. These poet-composers became known as *troubadours* in southern France and *trouvères* in northern France. A similar group, called *minnesingers*, flourished in Germany. See *Minnesinger*; *Troubadour*; *Trouvère*.

New forms of polyphonic music appeared during the 1100's and 1200's. The most important of these forms,

the motet, developed from organum. A motet consisted of a piece of plain song and two or more additional parts, each with different words.

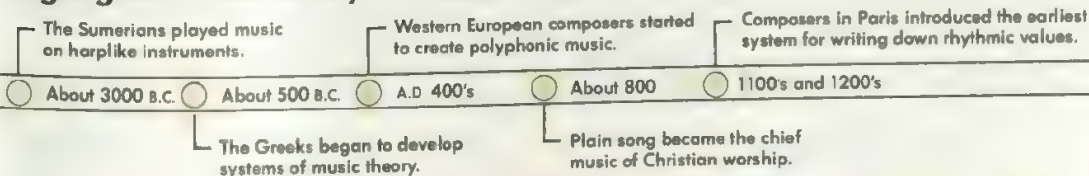
Music grew increasingly complex during the 1300's as rhythm became more varied. The motet and other forms of polyphony continued to develop. The French composer Guillaume de Machaut wrote the first polyphonic setting for the entire Roman Catholic Mass. Italian and English composers also produced important music.

The Renaissance period in music lasted from about 1450 to 1600. It occurred during the second half of the Renaissance, a time of outstanding cultural achievement in Europe. Composers of the Renaissance period experimented with new arrangements of tones and simpler rhythm. As a result, they produced fuller and richer sounds. Most music continued to be polyphonic and vocal, though instruments occasionally accompanied or replaced one or more of the voice parts.

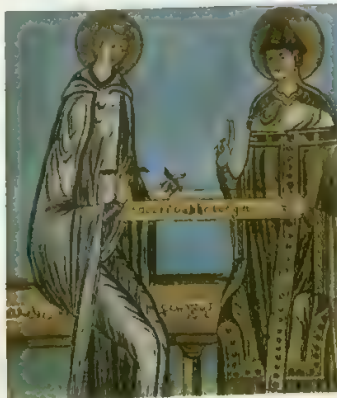
Many of the new developments in music occurred in Flanders, a region that included parts of what are now Belgium, the Netherlands, and northern France. A leading Flemish composer of the 1400's was Johannes Ockeghem.

In the late 1400's, composers began to use a style called *imitative counterpoint*. In this style, which became known as *fugue*, different voices or instruments followed one another and repeated the same melody with slight variations. Imitative counterpoint became the most common form of composition in the 1500's. Composers of this period included Orlando di Lasso of the Netherlands and Giovanni Palestrina of Italy.

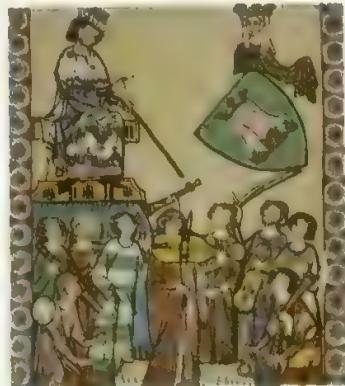
Highlights in the history of classical music



The **cithara** was an important stringed instrument of ancient Greece. The Greeks believed that music played on the cithara had a calming effect on listeners.



Guido d'Arezzo, left, an Italian monk, developed a revolutionary system of notation and method of sight-singing in the A.D. 1000's.



Troubadours often performed for royalty during the 1100's and 1200's in southern France. These poet-musicians helped popularize nonreligious songs.

In Italy, imitative counterpoint led to the development of the madrigal, a polyphonic secular song with three to six parts. Madrigals were written by such composers as Luca Marenzio of Italy, Ciprian de Rore of the Netherlands, and William Byrd and Thomas Morley of England.

Composers of the 1500's also created new forms of instrumental music. Some of these forms, including *canzoni* and *ricercari*, came from vocal music. Other forms were composed for one or more specific instruments. For example, the toccata was written for keyboard instruments. During the late 1500's, composers in Venice developed the concerto.

The baroque period, which lasted from about 1600 to 1750, featured elaborate, vividly expressive music. During this period, composers introduced several important vocal forms, including the cantata, oratorio, and opera. Instrumental music also flourished, especially chamber and orchestral music.

The modern system of major and minor scales, with 12 different notes, or tones, gradually came into use. This system is called *tonality*. Another feature of baroque music was the *continuo*, an accompaniment played by a bass instrument and a keyboard instrument.

Most of the new musical ideas of the period developed in Italy. Composers in other countries copied the styles and forms of Italian music. Leading composers during the 1600's included Claudio Monteverdi of Italy, Jean Baptiste Lully of France, Heinrich Schütz of Germany, and Henry Purcell of England.

In the late 1600's Italian composers created the *opera seria*. This form of opera was based on stories of ancient monarchs and of gods and goddesses from various

myths. Recitatives and arias became standard parts of operas during this period. The leading composer of opera seria was Alessandro Scarlatti of Italy, whose works became famous throughout Europe.

In instrumental music, the *trio sonata* became a popular style of chamber music during the baroque period. The trio sonata featured two melody instruments—usually violins—and a continuo played by a cello and a keyboard instrument. Orchestras played a new form of music known as the concerto grosso, which featured solo instrumentalists.

Baroque music reached its greatest heights in the work of two German composers, Johann Sebastian Bach and George Frideric Handel. Bach wrote music in nearly every form. During his own time, however, he was most famous as the organist and choirmaster of various churches in Germany. Bach's works included cantatas and organ compositions written for church services. His music overflows with rich harmonies and elaborate counterpoint. Musicians still study Bach's use of harmony in the *Well-Tempered Clavier*, a collection of 48 preludes and fugues, and in other works. Handel wrote more than 40 operas and over 30 oratorios.

The classical period. During the 1700's, the European middle class grew in size and importance. More and more people acquired an interest in music. Public concerts became increasingly popular, and composers wrote light, simple music that audiences could enjoy easily. Such *galant* music gradually developed into the classical style, which dominated composition from about 1750 to about 1820. This style emphasized balance and contrast among the movements of a work. Galant

Guillaume de Machaut, a French composer, wrote the first polyphonic arrangement for the Mass.

The modern system of major and minor scales came into use.

Johann Sebastian Bach of Germany completed Book I of the *Well-Tempered Clavier*.

1300's

1597

1600's

1722

Jacopo Peri of Italy composed *Dafne*, probably the first opera.

Jean Philippe Rameau, a French music theorist, published *Treatise of Harmony*.



Detail of a relief sculpture (1431) by Luca Della Robbia

During the Renaissance period, choirs consisted entirely of male singers. This marble sculpture shows a choir of boys singing a psalm.



Detail of *Psalms of Penitence* (1565-1570), a miniature painting on parchment by Hans Mielich Bayer, Staatsbibliothek, Munich, Germany

Chamber music flourished during the 1500's. The chamber orchestra above featured composer Orlando di Lasso of the Netherlands at the keyboard.



Detail of a German engraving (1720)

Johann Sebastian Bach composed many masterpieces during the first half of the 1700's. He is shown here conducting a performance of chamber music.

music expressed emotions in a refined, elegant way.

The sonata form appeared during the classical period, and composers used it in all types of instrumental music. Another important development was the *opera buffa*, a comic form of opera.

The greatest composers of the classical period were Joseph Haydn and Wolfgang Amadeus Mozart, both of Austria, and Ludwig van Beethoven of Germany. Haydn's works included symphonies, string quartets, sonatas, and operas. His instrumental music consisted of four movements that both contrasted with and balanced one another. Haydn built his movements on phrases that consisted of three or four notes. These phrases are called *motives*. Haydn's style became a model for later composers of the period.

Mozart composed in a greater variety of styles and forms than Haydn did. Mozart created much instrumental music, including sonatas, chamber music, symphonies, and piano concertos. He also wrote operas, some of which combined serious and comic elements. Mozart's *Don Giovanni* (1787) and *The Magic Flute* (1791) rank among the great operas of all time.

Beethoven composed most of his works during the classical period. He specialized in piano sonatas, string quartets, and symphonies. Many of Beethoven's works emphasize nonmusical ideas. For example, his ninth symphony expresses the ideal of human brotherhood. Beethoven wrote longer compositions than did Haydn and Mozart. His later piano sonatas and string quartets have an extraordinary range and power of expression.

The romantic era began about 1820. Composers of this period believed music should be highly imaginative

and emotional. A number of them developed characteristic personal styles.

Many shorter and simpler forms, such as German *lieder*, became popular during the romantic period. New instrumental forms also flourished. They included overtures, character pieces for piano, and symphonic poems.

Beethoven composed his later works during the first years of the romantic era. Franz Schubert, an early romantic from Austria, wrote more than 600 *lieder*, as well as piano solos, chamber music, and symphonies. Felix Mendelssohn, also of Germany, was noted for his piano and orchestral music. Still another German composer, Robert Schumann, wrote expressive symphonies, character pieces, and vocal music. Hector Berlioz of France became known for inventive types of orchestral compositions, many of them based on literary works. The Polish-born composer Frédéric Chopin wrote magnificent piano pieces.

Two composers of the mid-1800's, Franz Liszt of Hungary and Richard Wagner of Germany, gained fame for their extremely complex music. Liszt wrote brilliant piano music and established the symphonic poem as an important form. Wagner combined music, poetry, dance, and other arts in his revolutionary music dramas, which he based on various myths and legends. He used recurrent themes, called *leitmotifs*, that were associated with various characters and other aspects of the dramatic action.

Composers of the late 1800's used a wide variety of forms and styles. Anton Bruckner of Austria composed symphonies that had both religious and secular ele-

Messiah, an oratorio by George Frideric Handel of Germany, was first performed.

The Austrian composer Joseph Haydn completed his "London" Symphonies.

1742

1787

1794

Early 1800's

Wolfgang Amadeus Mozart of Austria wrote the opera *Don Giovanni*.

Ludwig van Beethoven of Germany composed many of his greatest works.



Detail of Leopold Mozart with His Two Children (about 1765), an oil painting on canvas by Louis Carrogis, Carravalet Museum Paris

As a young boy, Mozart showed extraordinary musical talent. This painting portrays him playing the piano, accompanied by his father and sister.



Beethoven's studio. Beethoven worked in this studio in his home during his final years. Although he became totally deaf, he continued to compose great music.



Franz Schubert of Austria wrote brilliant piano solos, chamber music, and symphonies. Here he is sitting at the piano, lower left, in a friend's home.

ments. Johannes Brahms of Germany wrote music in the classical tradition. Giuseppe Verdi created some of Italy's finest operas. The Bohemian composer Gustav Mahler wrote symphonies to be performed by a large orchestra. Many of these works involve vocal soloists and choruses. Richard Strauss of Germany became famous for his symphonic poems and operas.

About 1850, composers in eastern and northern Europe began to express the feelings of their people in music. They used elements of folk songs and folk dances in works that became known as *nationalistic music*. Nationalistic composers included Edvard Grieg of Norway; Alexander Borodin, Modest Mussorgsky, and Nikolai Rimsky-Korsakov of Russia; and Bedřich Smetana and Antonín Dvořák, both Czechs. Nationalistic elements are also important in the music of Peter Ilich Tchaikovsky, the most popular Russian composer of the 1800's. He became famous chiefly for his symphonies.

The 1900's have brought a number of new developments in classical music. For example, composers introduced harmonic principles that differed from the traditional system of harmony. Composers also often rejected the emotionalism of romantic music.

The first principal new musical approach was *impressionism*, a vivid, descriptive style that had originated in France in the late 1800's. Impressionism became widespread during the early 1900's. Claude Debussy of France, the leading impressionist composer, introduced new ideas in harmony and musical structure. Some of his works have sounds that suggest certain images, such as those of moonlight, wind, and the sea.

During the early 1900's, Austrian composer Arnold

Schoenberg began writing *atonal music*. In atonal music, there is no feeling of key. Schoenberg eventually developed *serialism*, a method of composition that uses all 12 notes of the scale in a predetermined series as the basis for a composition. Schoenberg used serialism in string quartets, symphonies, and other traditional forms. At first, his innovative music aroused protests from audiences and from conservative composers and critics. Schoenberg's students included two other noted Austrian composers, Anton Webern and Alban Berg.

Musical nationalism continued to flourish in the 1900's. The leading nationalistic composer was Béla Bartók of Hungary, who wrote piano pieces, string quartets, two ballets, and an opera. Among the other nationalistic composers were Charles Ives and Aaron Copland of the United States and Sergei Prokofiev and Dimitri Shostakovich of Russia.

Styles of popular music influenced many classical composers. For example, elements of jazz appeared in the works of such French composers as Maurice Ravel and Darius Milhaud.

A movement known as *neoclassicism* affected much of the music written after 1920. Neoclassical composers based their compositions on musical forms of the 1700's or earlier. The leading early neoclassical composers were the Russian-born Igor Stravinsky and Paul Hindemith of Germany. The early works of Stravinsky included such nationalistic ballets as *The Firebird* (1910) and *Petroushka* (1911). From the early 1920's to the early 1950's, however, he modelled his works on the music of Bach and various other composers of the past. After 1952, Stravinsky began to compose in the style of

The Polish-born composer Frédéric Chopin wrote outstanding compositions for solo piano.

Mid-1800's

Richard Wagner of Germany created operas that featured *leitmotifs* (recurrent themes).

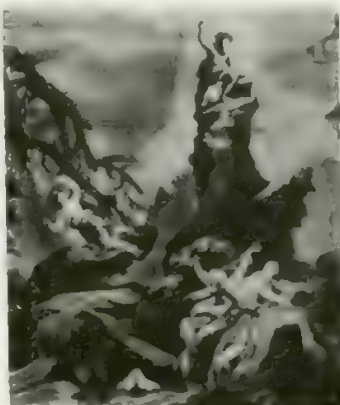
Johannes Brahms of Germany composed brilliant symphonies in the style of Beethoven

Late 1800's

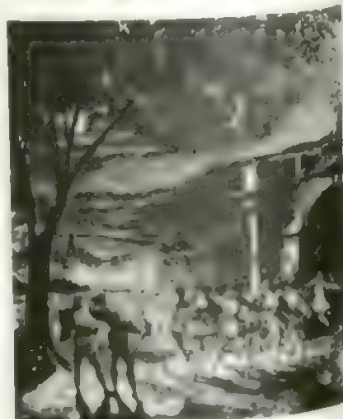
A vivid musical style called *impressionism* developed in France.



Hector Berlioz ranked as the leading French musician of the romantic period. He became famous throughout Europe as a composer, conductor, and music critic.



The Ring of the Nibelung, a group of operas by Wagner, was first performed in its entirety in 1876. This painting shows a scene from that performance.



Swan Lake, one of the world's great ballets, premiered in Moscow in 1876. Peter Ilich Tchaikovsky of Russia composed the music for this ballet.

Schoenberg. Hindemith composed in a variety of forms.

Since 1950, a number of composers have experimented with untraditional styles and with new methods of making sounds. The French-born American Edgard Varèse became known for his *electronic music*. In this kind of music, the composer uses electronic equipment to create sounds that have any desired pitch, loudness, tone, and duration. Another American composer, John Cage, helped develop *aleatory music*. In such music, all or part of the sounds depends on chance. The composer provides only a general outline of the composition. The performers are largely free to create their own melodies and rhythms. As a result, the piece varies with each performance.

Today, classical music consists of compositions that vary widely—from traditional to revolutionary—in style and form. Composers of the late 1900's include Alberto Ginastera of Argentina; Pierre Boulez and Olivier Messiaen of France; Carl Orff and Karlheinz Stockhausen of Germany; Sir Michael Tippett of Great Britain; Luciano Berio of Italy; Krzysztof Penderecki of Poland and Elliott Carter, George Crumb, and Charles Wuorinen of the United States.

Study aids

Related articles in *World Book*. See the *Arts* section of the articles on various countries, such as *Mexico* (Arts). See also:

Biographies

For biographies of other persons relating to classical music,

see the lists of *Related articles* at the end of *Hymn*; *Opera*; *Piano*; and *Violin*. See also:

American composers

Barber, Samuel
Bernstein, Leonard
Cage, John
Copland, Aaron
Crumb, George
Gershwin, George
Glass, Philip

Harris, Roy
Hovhanness, Alan
Ives, Charles E.
Menotti, Gian Carlo
Sessions, Roger
Thomson, Virgil

Australian composers

Grainger, Percy
Hill, Alfred
Mackerras, Sir Charles

Sculthorpe, Peter
Williamson, Sir
Malcolm

Austrian composers

Berg, Alban
Bruckner, Anton
Czerny, Karl
Haydn, Joseph
Kreisler, Fritz
Mahler, Gustav

Mozart, Wolfgang
Amadeus
Schoenberg,
Arnold
Schubert, Franz P.
Strauss (family)
Webem, Anton

British composers

Arnold, Malcolm
Bax, Sir Arnold
Bennett, Richard Rodney
Britten, Benjamin
Byrd, William
Davies, Sir Peter Maxwell
Delius, Frederick
Dowland, John
Elgar, Sir Edward W.
Gibbons, Orlando

Holst, Gustav
Morley, Thomas
Purcell, Henry
Rawsthorne, Alan
Sullivan, Sir Arthur S.
Tallis, Thomas
Tippett, Sir Michael
Vaughan Williams, Ralph
Walton, Sir William

Arnold Schoenberg of Austria developed *serialism*, a method of composition based on all 12 notes of the scale.

Edgard Varèse, a French-born composer, produced *Poème Electronique*, the first major work of electronic music.

1920's

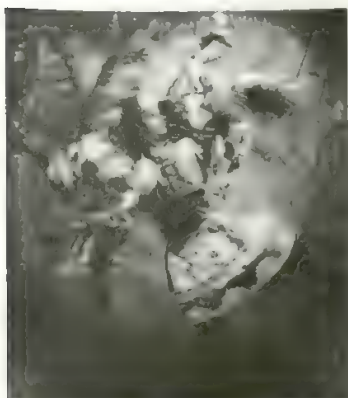
1930's

1958

1977

Dimitri Shostakovich developed a sophisticated modern style of Russian music.

The American composer Elliott Carter completed *A Symphony of Three Orchestras*.



The Firebird, a ballet by Igor Stravinsky of Russia, was first performed in 1910. The production starred Michel Fokine and Tamara Karsavina. *above*.



Wozzeck, an opera by Alban Berg of Austria, caused a sensation at its premiere in 1925. This picture shows a performance in Frankfurt, Germany, in 1931.



Electronic music is composed with special electronic equipment. The composer above is using a *synthesizer*, an instrument that makes a wide variety of sounds.

French composers

Berlioz, Hector	Ibert, Jacques
Bizet, Georges	Lully, Jean B.
Boulez, Pierre	Massenet, Jules
Couperin, François	Messiaen, Olivier
Debussy, Claude	Milhaud, Darius
Delibes, Léo	Offenbach, Jacques
Dukas, Paul A.	Poulenc, Francis
Fauré, Gabriel U.	Rameau, Jean Philippe
Franck, César	Ravel, Maurice
Gounod, Charles	Saint-Saëns, Camille
Honegger, Arthur	Satie, Erik

German composers

Bach (family)	Mendelssohn, Felix
Beethoven, Ludwig van	Meyerbeer, Giacomo
Brahms, Johannes	Orff, Carl
Bruch, Max	Schumann, Clara
Buxtehude, Dietrich	Schumann, Robert
Gluck, Christoph W.	Stockhausen, Karlheinz
Handel, George F.	Strauss, Richard
Henze, Hans Werner	Telemann, Georg P.
Hindemith, Paul	Wagner, Richard
Humperdinck, Engelbert	Weber, Carl Maria von

Italian composers

Bellini, Vincenzo	Paganini, Niccolò
Boccherini, Luigi	Palestrina, Giovanni
Boito, Arrigo	Pergolesi, Giovanni B.
Cherubini, Luigi	Puccini, Giacomo
Clementi, Muzio	Respighi, Ottorino
Corelli, Arcangelo	Rossini, Gioacchino A.
Dallapiccola, Luigi	Scarlatti, Alessandro
Donizetti, Gaetano	Scarlatti, Domenico
Leoncavallo, Ruggiero	Tartini, Giuseppe
Mascagni, Pietro	Verdi, Giuseppe
Monteverdi, Claudio	Vivaldi, Antonio

Russian composers

Borodin, Alexander	Rimsky-Korsakov, Nikolai
Glinka, Mikhail I.	Rubinstein, Anton G.
Khachaturian, Aram I.	Scriabin, Alexander
Mussorgsky, Modest	Shostakovich, Dimitri
Prokofiev, Sergei S.	Stravinsky, Igor F.
Rachmaninoff, Sergei V.	Tchaikovsky, Peter I.

Other composers

Albéniz, Isaac	Kodály, Zoltán
Bartók, Béla	Lasso, Orlando di
Chávez, Carlos	Liszt, Franz
Chopin, Frédéric F.	Nielsen, Carl A.
Dvořák, Antonín	Paderewski, Ignace J.
Falla, Manuel de	Penderecki, Krzysztof
Ginastera, Alberto	Sibelius, Jean
Grieg, Edvard	Smetana, Bedřich
Janaček, Leoš	Villa-Lobos, Heitor

Conductors

Barbirolli, Sir John	Mitropoulos, Dimitri
Barenboim, Daniel	Monteux, Pierre
Beecham, Sir Thomas	Ormandy, Eugene
Bernstein, Leonard	Ozawa, Seiji
Boulez, Pierre	Previn, Andre
Boult, Sir Adrian	Reiner, Fritz
Damrosch (family)	Sargent, Sir Malcolm
Davis, Sir Colin	Shaw, Robert
Fiedler, Arthur	Solti, Sir Georg
Furtwängler, Wilhelm	Stokowski, Leopold
Karajan, Herbert von	Szell, George
Klemperer, Otto	Toscanini, Arturo
Koussevitzky, Serge	Walter, Bruno
Levine, James	Wood, Sir Henry
Maazel, Lorin	Zukerman, Pinchas
Mehta, Zubin	

Elements of music

Counterpoint	Key	Sound
Harmonics	Pitch	Tone
Harmony	Rhythm	Treble

Instrumental musical forms

Concerto	Scherzo
Étude	Serenade
Fantasia	Sonata
Fugue	Suite
Intermezzo	Symphonic poem
March	Symphony
Overture	Variation
Rondo	Waltz

Vocal music

Ballade	Minnesinger
Barcarole	Minstrel
Bard	Passion music
Canon	Singing
Cantata	Song
Chorale	Troubadour
Lieder	Trouvère
Madrigal	Voice
Mastersinger	

Other related articles

Aleatory music	Korea (picture: Traditional Korean music)
Ballet	Metronome
Cecilia, Saint	Muses
Chamber music	Opera
Composer	Operetta
Electronic music	Oratorio
Gamelan	Orchestra
Greece, Ancient (The arts)	Suzuki method
Hymn	Tuning fork
India, Dance and music of	

Outline**I. Instrumental music**

- A. Solo music
- B. Chamber music
- C. Orchestral music

II. Vocal music

- A. Songs
- B. Choral music
- C. Operas
- D. Oratorios

III. Classical music forms

- A. Simple forms
- B. The sonata form
- C. The variation form
- D. Fugue
- E. Free form

IV. History

- A. Beginnings
- B. The Middle Ages
- C. The Renaissance period
- D. The baroque period
- E. The classical period
- F. The romantic era
- G. The 1900's

Questions

- What are the characteristics of baroque music?
- What are the three main techniques that composers use to give structure to their music?
- How do a symphony and a concerto differ?
- What is *aleatory music*? *Electronic music*?
- What are the principal kinds of instrumental music?
- What instruments make up a string quartet?
- What is *serialism* and who developed it?
- What is the major difference between an oratorio and an opera?
- How did chamber music get its name?
- What is the chief form of religious choral music?

A French classical landscape of the 1600's by Claude reflects the movement's admiration for balance, harmony, and order. The idealized rural setting and the subject matter taken from Greek mythology were also typical of French classical painting.



The Father of Psyche Sacrificing at the Temple of Apollo (1670; an oil painting on canvas)

Classicism is a philosophy of art and life that emphasizes order, balance, and simplicity. The ancient Greeks were the first great classicists. Later, the Romans, French, English, and others produced classical movements. Each group developed its own unique characteristics, but all reflected certain common ideals of art, humanity, and the world.

The qualities of classicism

Classicism contrasts with the philosophy of art and life called *romanticism*. Classicism stresses reason and analysis, while romanticism stresses imagination and the emotions. Classicism seeks what is universally true, good, and beautiful. Romanticism seeks the exceptional and the unconventional. Classical art looks to the past for its models. It often revives ancient Greek and Roman values, and is then called *neoclassicism*. Romanticism is often sympathetic to revolutions in society and art. Classical artists follow formal rules of composition more closely than romantic artists do. See **Romanticism**.

Classicists know that reality is complex. But they try to approach it through simple structures. For example, the classical playwright concentrates on essentials by restricting a play to a single line of progress that could happen on one day, in one place, or in nearby places.

The Italian artist Raphael and the French artist Nicolas Poussin painted pictures illustrating the finest qualities of classical art. Many of their pictures have a poetic mood, but the organization of the subject matter is always balanced, harmonious, and orderly. These qualities can be seen in Raphael's *Madonna of the Goldfinch* and Poussin's *St. John on Patmos*. Both of these pictures are reproduced in the **Painting** article. The works of the Italian composer Giovanni Palestrina and the French composer Jean-Philippe Rameau show the classical qualities of balance and clarity.

Great classical movements

The first important classical movement developed in ancient Greece and Rome. Another such movement appeared in Western Europe in the 1600's and 1700's.

Greece. The first classical period in the West arose in ancient Greece, and reached its height in the 400's and 300's B.C. The Greeks praised reason and denounced emotionalism and exaggeration. They tried to see all reality within a unified system that gave it meaning and direction. The sculptures of Phidias and Praxiteles are fine examples of well-proportioned human figures. Aeschylus, Sophocles, and Euripides wrote tragedies about the power of fate and the danger of excessive pride. See **Greek literature; Greece, Ancient** (The arts).

Rome. Roman classicism developed in two stages. These stages occurred during the age of Cicero from 80 to 43 B.C., and the age of Augustus from 37 B.C. to A.D. 14. The Romans adopted the Greek classical values, and added a unique emphasis on civilization as an organized, cooperative undertaking. Under the influence of the statesman and orator Cicero, civic responsibility gained a new importance. Rome's literature reached its highest achievement during the reign of Augustus. The classical poet Virgil wrote works on the development of civilization and on the heritage of Rome. The works of the classical poet Horace exemplify civilized attitudes toward society and life. See **Latin literature**.

France. The French classical movement of the 1600's developed the most diverse expression of classical values ever seen in the Western world. French classicists placed strong emphasis on reason in analysing ideas and human actions. The most important people in the intellectual and literary history of the French classical period include the mathematician-philosophers Blaise Pascal and René Descartes; the moralist writer Duc de

La Rochefoucauld; the writer of fables Jean de La Fontaine; and the dramatists Pierre Corneille and Jean Racine. See **French literature** (The classical age).

England. The English classical period followed French classicism. It arose in the late 1600's and reached its height during the first half of the 1700's. The English modelled their movement on the classicism of France, Greece, and Rome. They strove for good taste and truth to nature. For a more detailed discussion of English classicism, see **English literature** (The Augustan Age).

Germany. In Germany and in German-speaking Austria, music rather than literature best expressed classical ideals. Joseph Haydn, Wolfgang Amadeus Mozart, and Ludwig van Beethoven rank among the great classical composers (see **Classical music**). In the late 1700's in Germany, a classical literature flourished side by side with romantic literature. Johann Wolfgang von Goethe is often regarded as the finest classical and the finest romantic German writer.

There is a separate article in *World Book* for each person discussed in this article. See also **Russian literature** (The classical movement).








Classification, Scientific. Scientific classification is a method scientists have developed to arrange all of the world's organisms in related groups. It is the orderly arrangement of all living things. Scientific classification indicates certain relationships among all organisms. Detailed scientific classifications also show how ancient and extinct biological groups fit into this arrangement. The classification of organisms is a science called *taxonomy* or *systematics*.

Scientific classification is an interpretation of facts. It is based on the opinion and judgment a biologist forms after studying many living and preserved dead organisms. Most biologists use the same basic framework for classification. But not all biologists agree on how different groups of organisms fit into this scheme, and so classifications often differ in details.

The language of classification. Latin and Greek words are used in scientific classification, because early scholars used these languages. Every known organism belongs to a particular *species*. Each species has a two-part scientific name. Most of these names come from Greek or Latin words. We call this system of names the

How organisms are classified

The illustrated tables below are simplified examples of classification. They show how a North American red squirrel (*Tamiasciurus hudsonicus*) and a common buttercup (*Ranunculus acris*) can be separated from any other species of animal or plant. As you go down the tables, from kingdom to species, the animals and plants in each group have more and more features in common. Individuals in a species have so many similar features that they look alike.

Animal kingdom	
	Kingdom Animalia
	Phylum Chordata
	Class Mammalia
	Order Rodentia
	Family Sciuridae
	Genus <i>Tamiasciurus</i>
	Species <i>Tamiasciurus hudsonicus</i>

binomial system of nomenclature, or binomial nomenclature. These are Latin terms that mean *two-name naming*. The two names identify an organism by indicating which species it belongs to.

Organisms are known by different common names in different regions of the world. However, each organism has only one correct scientific name, and scientists anywhere in the world can recognize the organism by its scientific name. For example, the same large member of the cat family may be known in various parts of North America and South America as a puma, cougar, mountain lion, panther, or león. The cat's scientific name is *Felis concolor*. Scientists from any country can identify the animal by that name no matter what language they speak.

International commissions of scientists establish the rules for adopting scientific names. Some scientific names are descriptive. The scientific name of the spotted skunk, for example, is *Spilogale putorius*, which means *smelly, spotted weasel*. But many scientific names have no descriptive meaning.

Groups in classification. Seven chief groups make up a system in scientific classification. The groups are: (1) kingdom, (2) phylum or division, (3) class, (4) order, (5) family, (6) genus, and (7) species. The kingdom is the largest group. The species is the smallest. Every known organism has a particular place in each group.

Kingdom is the largest unit of biological classification. Until the 1960's, most biologists formally recognized only two major kingdoms—Animalia, the animal kingdom, and Plantae, the plant kingdom. But as more information about the microscopic structure and biochemistry of organisms became known, scientists realized that a two-kingdom classification system was not exact enough. Today, most biologists use a system that recognizes five kingdoms of organisms. These kingdoms are named Animalia, Plantae, Fungi, Protista, and Monera.

The kingdom Animalia is the largest kingdom. It has more than 1 million named species. These species include the organisms that most people easily recognize as animals, such as human beings, deer, fish, insects, and snails. The kingdom Plantae consists of more than 350,000 species. It includes those organisms that most people easily recognize as plants, such as magnolias, sunflowers, grasses, pine trees, ferns, and mosses. The kingdom Fungi has more than 100,000 species. These species include fungi, such as mushrooms and bread moulds, as well as the lichens.

The kingdom Protista consists of more than 100,000 species. This kingdom includes green, golden, brown, and red algae; ciliates; sporozoans; sarcodines; and flagellates. The kingdom Monera, also called *Prokaryotae*, consists of bacteria, including blue-green algae or cya-

Plant kingdom

Kingdom
Plantae



Division
Anthophyta



Plants that have (1) flowers with reproductive organs called *ovaries* that protect *ovules* (structures that can develop into seeds)

Class
Dicotyledonae



Plants that (1) have flowers with ovaries and (2) develop from plant embryos with two *cotyledons* or *seed leaves*

Order
Ranales



Plants that have (1) flowers that have ovaries, (2) embryos with two cotyledons, and (3) *floral parts* (petals, sepals, stamens) that grow from beneath the ovary

Family
Ranunculaceae



Plants that have (1) flowers that have ovaries, (2) embryos with two cotyledons, (3) floral parts growing from beneath the ovary, and (4) many spirally arranged stamens

Genus
Ranunculus



Plants that have (1) flowers that have ovaries, (2) embryos with two cotyledons, (3) floral parts growing from beneath the ovary, (4) many spirally arranged stamens, and (5) all petals identical

Species
Ranunculus acris



Plants that have (1) flowers that have ovaries, (2) embryos with two cotyledons, (3) floral parts growing from beneath the ovary, (4) many spirally arranged stamens, (5) all petals identical, and (6) yellow flowers

nobacteria. There are more than 10,000 known species in this kingdom.

Division, or phylum, is the second largest group. The kingdoms Protista, Fungi, and Plantae are classified into *divisions*. In the animal kingdom, the term *phylum* is used instead of division. Scientists disagree on which of these two terms should be used for the kingdom Monera.

The animal kingdom may be divided into 20 or more phyla. All animals with backbones belong to the phylum Chordata. The plant kingdom has 10 divisions. All plants that have flowers are classified in the division Anthophyta.

Class members have more characteristics in common than do members of a division or phylum. For example, mammals, reptiles, and birds all belong to the phylum Chordata. But each belongs to a different class. Apes, bears, and mice are in the class Mammalia. Mammals have hair on their bodies and feed milk to their young. Reptiles, including lizards, snakes, and turtles, make up the class Reptilia. Scales cover the bodies of all reptiles, and none of them feed milk to their young. Birds make up the class Aves. Feathers grow on their bodies, and they do not feed milk to their young.

Order consists of groups that are more alike than those in a class. In the class Mammalia, all the animals produce milk for their young. Dogs, moles, raccoons, and shrews are all mammals. But dogs and raccoons eat flesh, and are grouped together in the order Carnivora, with other flesh-eating animals. Moles and shrews eat insects, and are classified in the order Insectivora, with other insect-eating animals.

Family is made up of groups that are even more alike than those in the order. Wolves and cats are both in the order Carnivora. But wolves are in the family Canidae. All members of this family have long snouts and bushy tails. Cats belong to the family Felidae. Members of this family have short snouts and short-haired tails.

Genus consists of very similar groups, but members of different groups usually cannot breed with one another. Both the jackal and the wolf are in the genus *Canis*. But jackals and wolves generally do not breed with one another.

Species is the basic unit of scientific classification. Members of a species have many common characteristics, but they differ from all other forms of life in one or more ways. Members of a species can breed with one another, and the young grow up to look very much like the parents. No two species in a genus have the same scientific name. The jackal is *Canis aureus*, and the wolf is *Canis lupus*. Sometimes groups within a species differ enough from other groups in the species that they are called *subspecies* or *varieties*.

Development of classification. For thousands of years people have tried to classify living things. Early human beings divided all organisms into two groups: (1) useful, and (2) harmful. As people began to recognize more kinds of living things, they developed new ways to classify them. One of the most useful was suggested by the Greek philosopher and naturalist Aristotle, who lived during the 300's B.C. Only about a thousand organisms were known in his time. He classified animals as those with red blood—animals with backbones—and those with no red blood—animals without backbones.

He divided plants by size and appearance as herbs, shrubs, or trees. Aristotle's scheme served as the basis for classification for almost 2,000 years.

During the 1600's, the English biologist John Ray first suggested the idea of species in classification. But the basic design for modern classification began with the work of the Swedish naturalist Carolus Linnaeus in the 1700's. Linnaeus classified organisms according to their structure and gave a distinctive two-word name to each species. Many of Linnaeus' groupings from species through orders still are accepted today. But his higher groupings often were based on superficial physical resemblances. Modern classifications are based on more microscopic structural and biochemical characteristics, as well as on presumed evolutionary relationships among organisms (see **Evolution** [Comparative studies of species]). Classifications continue to change as more information becomes available.

Related articles in World Book include:

Animal (table: A classification)	Kingdom
Botany	Linnaeus, Carolus
Flower (How flowers are named and classified; table: Representative families of flowers)	Monera
Fungi	Plant (table: A classification of the plant kingdom)
	Protista

Claude (1600-1682) was a French painter who established a tradition of landscape painting that influenced artists in Europe and America for 200 years. Claude's full name was Claude Gellée, but he is often called Claude Lorrain, or Lorraine, after his native province of Lorraine. Claude settled in Rome in 1627 and lived there for the rest of his life.

Claude's landscapes show the Italian countryside bathed in golden light. They have a feeling of calm and peace, sometimes tinged with sadness. Peasants and their farm animals appear in some of his paintings. In others, characters from mythology contribute to the mood. Claude also painted seaport or river scenes with the setting sun reflected in the water.

Like other artists of his time, Claude went into the countryside to make sketches but completed his paintings in his studio. Patrons would have been insulted to receive a mere copy of nature that the artist had not bothered to idealize. Claude's landscapes were immediately popular and continued to be influential for generations. His work was especially popular in England in the 1700's. There it influenced garden design and helped shape the style of the great English landscape painter J. M. W. Turner.

See also **Classicism** (picture).

Claudel, Paul (1868-1955), was a French writer and diplomat. He became one of the foremost French poets and playwrights in the early 1900's and helped provide a new religious focus to the literature of his time. His writings are examples of the Roman Catholic revival in French literature and philosophy.

Early in his life, Claudel lost his religious faith. But on Christmas Day in 1886, he had a spiritual experience while listening to evening prayers in the Cathedral of Notre Dame in Paris. This experience led to the return of his faith and to his acceptance of orthodox Catholicism.

Claudel expresses his deep religious faith in such lyric poems as *Cinq Grandes Odes* (1910). But he is best known as a playwright. His most famous play, *The Tid-*

ings Brought to Mary (1912), portrays the triumph of divine love. It illustrates themes common throughout Claudel's work: the relationship between human love and salvation, the link between humanity and divine will, and the necessity of self-sacrifice for the redemption of others.

Claudel was born in Villeneuve-sur-Fère, near Soissons, France. Between 1893 and 1935, he worked in several countries as a French diplomat. He served as France's ambassador to Japan, the United States, and Belgium. Claudel was elected to the French Academy in 1946.

See also **French literature** (The four masters).

Claudius (10 B.C.-A.D. 54) was the emperor of Rome from A.D. 41 to 54. Claudius was an excellent ruler. He formed a civil service system that placed specialized departments, headed by secretaries, in charge of the various branches of government. He built aqueducts, drained marshes, and made a harbour at Ostia, a town near Rome. Claudius conquered parts of England, and the Balkan Peninsula (then called Thrace). He also granted Roman citizenship to certain persons in Rome's provinces.

Claudius was born in Lugdunum (now Lyons), France. His full name was Tiberius Claudius Nero. Lame and a stutterer, Claudius was kept from public view in his youth. He spent his time studying and writing histories of Etruria and Carthage. Claudius married several times. When he married his niece Agrippina the Younger, he adopted her son Nero. Some historians believe Agrippina murdered Claudius so that Nero could become emperor (see Nero).

Clause is a group of words with a subject and a predicate. A complete sentence is called a *main*, or *independent*, clause. For example, *we were practising* is a main clause. A *subordinate*, or *dependent*, clause begins with a relative pronoun, such as *which*, *who*, or *that*; or with a subordinating conjunction, such as *although*, *if*, *because*, *so* *that*, *unless*, or *while*. Thus, *when we were practising* is a subordinate clause.

Subordinate clauses are classified as *restrictive* or *nonrestrictive*. A restrictive clause is binding upon the word it modifies. To omit it would alter the meaning of the sentence. In "The man *who was coming toward me* suddenly stumbled," the subordinate clause is restrictive because it tells us who stumbled. A nonrestrictive clause can be omitted without changing the sentence's essential meaning. In "George, *who was coming toward me*, suddenly stumbled," the clause is nonrestrictive. The word "George" tells us who stumbled. The clause places no further restrictions upon the subject. It merely adds information. Nonrestrictive clauses are enclosed by commas. Restrictive clauses are not.

See also **Sentence**.

Clausewitz, Karl von (1780-1831), was a Prussian army officer and military theorist. His theories and observations about war, published in the book *On War* (1832-1834), influenced military strategy for more than 100 years.

Clausewitz was born in Burg, Prussia (now Burg, Germany). He joined the army in 1792 and fought in numerous battles against the French armies of Emperor Napoleon I. These battles included the campaign of 1815, when Napoleon was finally defeated. In 1818, Clau-

sewitz became director of the War College in Berlin.

In his writings, Clausewitz observed that armies of citizens fighting for their nation showed greater determination than professional soldiers fighting only for territory. Clausewitz' most original contribution was his analysis of the close relationship between the army and the nation. To Clausewitz, war was merely "the pursuit of diplomacy by other means." Thus, it was necessary to consider the political interests of the nation as more important than military goals. He also stressed that a nation at war must take risks and act boldly to obtain a decisive and total victory.

Clausius, Rudolf Julius Emmanuel (1822-1888), a German physicist, helped establish thermodynamics as a science. In 1850, he stated the second law of thermodynamics: "Heat cannot of itself pass from a colder to a hotter body" (see **Thermodynamics**). He derived an equation that relates the saturated vapour pressure of a liquid to the temperature. He also developed a theory to explain electrolysis (see **Electrolysis**). Clausius was born in Köslin, Germany (now Koszalin, Poland).

Claustrophobia. See **Phobia**.

Clavichord is a keyboard musical instrument that was a forerunner of the piano. The clavichord's tone is produced by metal blades that strike the instrument's wire strings when keys are pressed down. The blades, called *tangents*, remain in contact with the strings as long as the keys are held down. This action allows the player to control the tone by making slight changes in pitch. This is done by pressing down on the key and changing the tension of the string while it is still sounding. This is an important feature of the instrument. The word *clavichord* comes from the Latin words *clavis*, which means *key*, and *chorda*, which means *string*.

The clavichord dates from the 1400's. It produces soft tones, and so was used for musical practices and entertaining small gatherings rather than for playing in public concerts. The instrument became especially popular in Germany. During the 1700's, the piano was developed and began to replace the clavichord.

See also **Piano** (History).

Clavicle. See **Collarbone**.

Claw. See **Animal** (Ways of life; picture).

Clay is a substance present in most kinds of soil. Geologists define clay as extremely small particles of soil that measure less than 4 micrometres in diameter. The word *clay* also refers to earthy material composed of certain kinds of silicate minerals that have been broken down by weathering.

Clay consists mainly of tiny, sheetlike particles of alumina and silica bound together by water. Various other materials in clay may give it different colours. For example, iron oxide may colour clay red. Clays that contain various amounts of carbon compounds may be different shades of grey.

The clay in soil has a vital role in farming. For example, it absorbs ammonia and other gases needed for plant growth. Clay also helps soil retain the fertilizing substances supplied by manure. Without clay, soil would not keep its fertility from year to year. However, too much clay makes soil stiff and heavy, and prevents the movement of air and water through soil.

There are two general types of clay. The two types react differently when mixed with water. **Expandable**



An artist uses clay to model an earthenware vase. Sculptures, dishes, and other objects may also be created from clay.

clay swells when water is added to it. Expandable clay can absorb so much water that the clay itself becomes a liquid. *Nonexpandable clay* becomes soft but not liquid when mixed with water. The petroleum industry uses a kind of expandable clay as a chemical agent in the process of oil refining.

Ceramics industries use nonexpandable clay in making bricks, pottery, tiles, and many other products. For example, pottery makers mould moist clay into almost any shape and bake it in hot ovens called *kilns*. Heat removes the water from the clay. The clay then becomes permanently hard and cannot be softened by adding water to it. The whitest kind of clay, *kaolin* or *china clay*, is used in making porcelain. The paper industry also uses kaolin, which serves as a filler that adds whiteness and strength to paper. In addition, kaolin gives some kinds of paper a smooth, shiny surface. *Fire clay* contains a large percentage of silica and can stand high temperatures. It is used in making firebrick and furnace linings.

Related articles in *World Book* include:

Alumina	Fuller's earth	Pottery
Bentonite	Kaolin	Silica
Brick	Loam	Soil
Ceramics	Marl	Terracotta
Feldspar	Porcelain	Tile

Clay, Cassius. See Ali, Muhammad.

Clay, Henry (1777-1852), was a leading American statesman for nearly 50 years. Clay became known as the Great Compromiser because he repeatedly helped settle bitter disputes over slavery between the Northern and Southern states. Clay served as speaker of the U.S. House of Representatives, a U.S. senator, and a U.S. secretary of state. He campaigned for president unsuccessfully five times.

Clay, the son of a Baptist minister, was born on April 12, 1777, in Hanover County, Virginia. He was elected to Kentucky's state legislature in 1803, to the U.S. Senate in

1806, and to the U.S. House of Representatives in 1811. By 1815, Clay had become the most important leader of the National Republican Party. Clay and other National Republicans helped form the Whig Party in 1834.

Clay died in Washington, D.C., in June 1852 and was buried in Lexington, Kentucky.

Clay, Lucius Dubignon (1897-1978), served as commander in chief of the United States armed forces in Europe, and as military governor of the U.S. zone in Germany from 1947 to 1949. In 1948, what was then the Soviet Union blockaded all supply routes to the Western section of Berlin, hoping to drive out of Berlin the forces of the United States, Great Britain, and France. But the Berlin Airlift, directed by Clay, flew food and other supplies into the city.

Clay was born in Marietta, Georgia, U.S.A., and graduated from the United States Military Academy in 1918. He then served as an Army engineer. During World War II, Clay directed the delivery of supplies to the front lines. He retired from the Army in 1949, and became associated with several civilian firms. Clay served as an adviser to the Office of Defense Mobilization in 1951. In 1961 and 1962, he served as the personal representative of President John F. Kennedy in Germany. From 1968 to 1974, Clay was chairman of Radio Free Europe (see *Radio Free Europe/Radio Liberty*). He wrote a book, *Decision in Germany* (1950), based on his experiences in military government.

Clay pigeon shooting is a sport in which a person shoots at clay discs that are thrown into the air by a machine. Clay pigeon shooters use a shotgun that fires shells holding about 500 lead pellets. The discs measure no more than 11 centimetres in diameter. A machine called a *trap* hurls the discs into the air at speeds of almost 100 kilometres an hour. The trap is housed in a structure called a *traphouse*, which is partially beneath the ground.

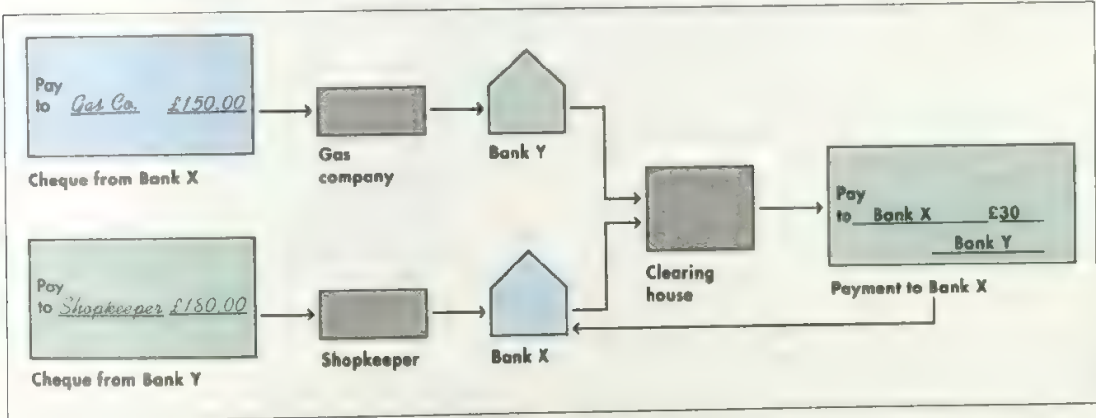
A clay pigeon shooter stands behind the traphouse in one of five lanes, called *stations*. When the shooter calls



Clay pigeon shooting is a sport in which a person shoots at clay discs with a shotgun. A machine called a trap throws the discs into the air. The traps are in low structures called *traphouses*, top.

How a clearing house works

A clearing house is an institution used by banks to settle their debts with one another. For example, suppose Bank Y has a cheque for £150 from a customer of Bank X, and Bank X has a cheque for £180 from a customer of Bank Y. Instead of paying the cheques separately, the banks send them to a clearing house. Both debts could be settled at once if Bank Y paid £30 to Bank X.



out "pull," a disc is launched, and the shooter fires at it once. A disc is called "dead" if a visible piece falls from it. If the shooter misses, the disc is called "lost." In most competitions, 100 discs are shot in groups of 25. The shooter fires five times from each of the five stations.

Clay pigeon shooters compete in *singles, doubles, and handicap* events. In singles, one disc at a time is launched. In doubles, competitors shoot at two discs launched simultaneously. In both singles and doubles, shooters stand 15 metres behind the traphouse. In a handicap event, the greater the shooters' ability, the farther they must stand behind the traphouse. The distance varies from 16 to 25 metres.

A related sport called *skeet shooting* has eight stations and two traphouses above ground. See *Skeet*.

Clayton Antitrust Act. See *Antitrust laws*.

Clayton-Bulwer Treaty, signed by the United States and Great Britain in 1850, gave both countries an equal share in the protection of a canal to be built through Central America. Both countries agreed to maintain the neutrality of the canal and the land on either side of it. The treaty was named after John M. Clayton, American secretary of state, and Sir Henry Bulwer (1801-1872), British ambassador to the United States. This treaty became unpopular in the United States. In 1901, the Hay-Pauncefote Treaty replaced the Clayton-Bulwer Treaty. It granted the U.S. the right to build and manage the canal. See also *Hay-Pauncefote Treaty*.

Cleaning. See *Dry cleaning*.

Cleanliness. See *Bath (Bathing for cleanliness); Health (Cleanliness); Sanitation*.

Clearing house is an institution where financial transactions such as bank payments are set against each other and the final balance for each bank or other institution is settled. The purpose of a clearing house is to reduce the number of exchanges of funds to a minimum. The use of a clearing house means that each bank can have its outpayments lumped together and set against incoming receipts. Only one payment is necessary instead of many individual transactions.

Although clearing systems vary throughout the world, the process in most developed countries is similar to

that in the United Kingdom, where the first clearing house originated in the 1770's. In England, most of the large commercial banks are members of the Bankers' Clearing House. Those that are not members employ one of the member banks as their agent. This agent is known as a *correspondent bank*. The London Clearing House, in Lombard Street, London, makes an important contribution to London's reputation as an international financial centre.

The process of clearing debts between financial institutions is an extremely complex and sophisticated business. Here is an example of a simple situation.

(1) A man (A) gives a £150 cheque drawn on his account at Bank X to the gas company (B). The gas company pays the cheque into its own account at Bank Y. Bank Y sends the cheque to its head office for transfer to the clearing house.

(2) A woman (C), who also has an account at Bank Y, gives a cheque for £180 to a shopkeeper (D) who has an account at Bank X. This cheque is transferred to the Bank X head office for transfer to the clearing house.

(3) At the clearing house the Bank Y representative gives A's cheque to the Bank X representative, claiming the £150 for his client B. At the same time, the Bank X representative hands over to Bank Y the £180 cheque to claim the money for his client D. This means the final balance is £30, which Bank Y owes to Bank X. The transfer for this amount is made through the clearing house.

After the clearance, the accounts of A, B, C, and D are increased and reduced by the relevant amounts. If an account holder has insufficient money in his or her account to pay the debt, the bank—which has already received the money for it—must be advised of the fact within a period specified by the clearing house, or it is assumed the cheque may be honoured.

Cleary, Beverly (1916-), is an American author of books for children. She is best known for her series of books about the adventures of two children named Henry Huggins and Ramona Quimby. The two characters and their friends live in a middle-class suburb of Portland, Oregon, U.S.A. Cleary's books are noted for their humour and for their realistic and natural dialogue.

Cleary's first book was *Henry Huggins* (1950). She featured Henry in several more books and also included him as a minor character in other stories. Ramona first appeared as a major character in *Beezus and Ramona* (1955). Cleary's other children's books include *Ellen Tebbits* (1951), *The Real Hole* (1960), *The Mouse and the Motorcycle* (1965), and *Runaway Ralph* (1970). Cleary was born in McMinnville, Oregon. In 1975, she received the Laura Ingalls Wilder Award for her contributions to children's literature. Cleary won the 1984 Newbery Medal for *Dear Mr. Henshaw* (1983).

Cleavage. See **Gem** (Qualities); **Mineral** (Cleavage; Chemical bonds); **Diamond** (What diamonds are).

Cleaver, Eldridge (1935-), became known for preaching the doctrine of *Black Power*. According to this doctrine, blacks must organize politically so they can deal with white society from a position of strength. Cleaver became best known for his book *Soul on Ice* (1968). Critics praised the book's insight into black attitudes toward American society.

Leroy Eldridge Cleaver was born in Wabbaseka, Arkansas, U.S.A., and grew up in California. As a youth, he spent several years in prison. In 1958, he was convicted of assault with intent to kill and given a 2- to 14-year sentence. He was paroled in 1966 and joined the Black Panther Party. This was a radical political organization founded to promote the rights of blacks in American society. Cleaver fled to Algeria after he became involved in a shooting incident in California in 1968. He returned to the United States in 1975. He said he had experienced a "religious conversion" and gave up many of his earlier political beliefs. He described his conversion in his book *Soul on Fire* (1978). Cleaver then was arrested for parole violation. He was released on probation in 1979.



Eldridge Cleaver

Cleethorpes (pop. 67,500) is a local government district in the county of Humberside, England. It contains the popular seaside resort of Cleethorpes and the deep-sea port of Immingham. Cleethorpes district takes in part of the Lincolnshire Wolds, and arable and fruit farming are important in the area.

See also **Humberside**.

Cleft lip. See **Cleft palate**.

Cleft palate is a birth defect in which there is a split in the roof of the mouth. Many people born with a cleft palate also have a *cleft lip*—a split through the upper lip. Cleft lip—with or without cleft palate—occurs in about 1 out of every 700 births. Cleft palate alone occurs in about 1 out of every 2,500 births.

Clefts result when the tissues that form the roof of the mouth or the lip fail to close up in the unborn baby. Research indicates that this may be caused by a combination of environmental and hereditary factors.

A cleft palate starts at the rear of the mouth. In some cases, it involves only the *soft palate*—the muscular tissue that forms the rear part of the roof of the mouth. In



Clematis do not have petals. The coloured parts of the clematis, which look like petals, are in fact the *sepals*. The sepals protect the developing inner parts of the flower. In most flowers, the sepals are green.

other cases, it extends into the *hard palate*—the bony tissue that makes up the front part of the mouth's roof. It may even extend through the gum.

Speech defects are one of the chief problems caused by a cleft palate. During normal speech, the soft palate rises to separate the mouth and nasal cavities. Such separation cannot be attained with a cleft palate, and certain sounds cannot be formed properly. Another serious problem is chronic ear infections. These result if the cleft palate interferes with the drainage of fluids through the *Eustachian tube*. This tube connects the middle ear with the back of the throat.

A cleft in the lip can be *complete* (extending into the nostril) or *partial* (stopping before the nostril). It may occur on one or both sides of the lip, and it may occur alone or with a cleft palate. A cleft lip is sometimes called a *harelip*, because it resembles the split lip of a hare. By itself, a cleft lip is chiefly a defect in appearance.

Cleft palates and lips can be repaired by surgically joining the split structures. Surgical repair of a cleft lip often produces almost normal appearance. Repair of a cleft palate greatly improves speech ability. However, some patients require speech therapy, additional surgery, or both to obtain usable speech. If clefts extend into the gum, orthodontic treatment may be needed to correct the angle of the teeth.

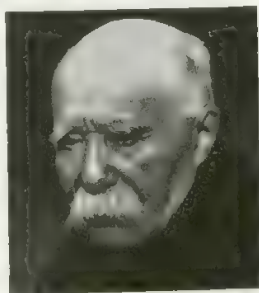
Cleisthenes was a statesman in ancient Athens. He established a democratic constitution there after Hippias, who held complete political power, was overthrown in 510 B.C. Cleisthenes was the head of the noble Alcmaeonid clan. This clan used an *oracle* (prophet) to persuade Cleomenes, the king of Sparta, to overthrow Hippias. After that, Cleisthenes gained public support and he set up a democratic form of government. He then reformed the Athenian tribal organization, ending the political control of the noble clans. The government had a council of 500 members who were chosen each year in a draw. Membership of the council was open to any citizen.

zen. Some scholars believe that to protect the new democracy, Cleisthenes enacted a law providing for *ostracism* (banishment) of politicians the people thought were dangerous. See also **Athens** (History).

Clematis is any one of a group of perennial herbs or woody vines that grow throughout Asia, Europe, and North America. Several small-flowered kinds are called *virgin's-bower*. The vines may climb 3 metres high and have flowers 15 centimetres wide. Clematis flowers may be blue, violet, white, yellow, pink, or red. After the flowers fade, the plant bears small dry fruits. The fruits often have long feathery tufts attached. Clematis are popular garden plants. There are many cultivated varieties with large, disc-shaped flowers. Clematis generally prefer a rich, well-drained soil. They are best planted with the roots in a cool, shaded site, but with the climbing part of the plant in sun or partial shade.

Scientific classification. Clematis belongs to the buttercup family, Ranunculaceae.

Clemenceau, Georges (1841-1929), a French statesman, led France triumphantly through the last and most difficult period of World War I. In 1917, when he was 76, he became premier of France for the second time. He exercised powerful leadership with his slogan, "I make war!" and became known as "The Tiger of France." He presided over the Paris Peace Conference, where he insisted on severe terms for Germany and sought to obtain the left bank of the Rhine River for France. Clemenceau ran for president of France in 1920, but lost to Paul Deschanel. He resigned as premier the day after he was defeated.



Georges Clemenceau

Clemenceau was born in Mouillieron-en-Pareds, near La Roche-sur-Yon, France. Trained as a doctor, he travelled and taught for a time in the United States, where he married an American. When he returned to France, he became mayor of Montmartre, a section of Paris. He helped defend Paris against the Germans in 1870. Clemenceau served as a deputy from 1876 to 1893, and as premier from 1906 to 1909.

Clemens, Samuel Langhorne. See Twain, Mark.

Clement I, Saint (? -about A.D. 101), was elected pope about A.D. 92. He is traditionally regarded as the third in succession to Saint Peter as bishop of Rome. Clement is most famous for a letter he wrote to the church in Corinth, probably in A.D. 96. The letter strongly condemned pride and arrogance within the church, and clarified the order of succession from bishop to *presbyter* (elder) to *deacon* (assistant). In later years, Clement's letter was regarded as the first exercise of papal authority in the affairs of a Christian church outside Rome. But Clement's concerns in writing the letter were spiritual and fraternal, not legal. The letter is the oldest surviving Christian text except for the Scriptures.

Clement was a citizen of Rome. He may have been the Clement who worked with Saint Paul at Philippi. Many legends surround Clement's life. According to one, he

was martyred by being thrown into the sea with an anchor tied around his neck. None of the legends can be verified. His feast day is November 23.

Clement VII (1342-1394) was an *antipope*—that is, a man determined to have improperly claimed to be or served as pope. His reign began in 1378 and marked the beginning of a period in church history known as the Great Schism. See **Roman Catholic Church** (The Great Schism).

Clement was born in Geneva (now Geneva, Switzerland) and was known as Robert of Geneva before being elected pope. Pope Gregory XI made him a cardinal in 1371. Gregory sent Robert to Italy to make arrangements for the return of the pope to Rome after the long papal residence in Avignon, in what is now France. Gregory died in 1378, shortly after returning to Rome. Robert and the other cardinals elected a new pope in April 1378 who took the name Urban VI. Urban had an unstable personality and soon antagonized many cardinals. The French cardinals claimed Urban's election was illegal because they argued it had been held under threat of violence. They withdrew their allegiance and elected Robert pope in September 1378.

Many European countries recognized Clement as the true pope. However, the church now considers Urban VI and his successor, Boniface IX, as the legitimate popes during Clement's reign.

Clement VII (1478-1534) was elected pope in 1523 and reigned during a stormy period in European religious and political affairs. Clement was born in Florence, Italy. His given and family name was Giulio de' Medici. His cousin, Pope Leo X, made him a cardinal in 1513. The Medici were a powerful family in Florence and after his election, Clement determined to preserve his family's control of the city. This control was threatened by struggles between the Holy Roman Empire and France for dominance in Italy. Clement shifted sides repeatedly. This policy proved disastrous when the forces of Holy Roman emperor Charles V captured King Francis I of France in 1525. They then raided Rome in 1527, forcing the pope to take refuge in the Castel Sant'Angelo.

Clement's concentration on Italian politics interfered with any effective papal response to the emerging Protestant Reformation. Lutheranism spread in Germany and was winning over Scandinavia. Clement's weak handling of the divorce case of King Henry VIII of England led to the split from Rome by the English church and the start of the Reformation in England.

Clement VIII (1536-1605) was elected pope in 1592, during the time of renewal and reform in the Roman Catholic Church known as the Counter Reformation. As pope, Clement typified the spiritual ideals of Catholic reform. A pious man, he fasted rigorously, practised extensive devotions, and regularly visited on foot the pilgrimage churches of Rome. He issued a corrected edition of the Vulgate Bible and also revised the main church liturgical books. In 1595, Clement recognized Henry of Navarre, a convert from Protestantism, as King Henry IV of France. Clement presided over the Jubilee of 1600, which attracted millions of pilgrims to Rome.

Clement was born in Fano, Italy. His given and family name was Ippolito Aldobrandini. He studied law and held positions on several key papal commissions. He became a cardinal in 1585.

Clementi, Muzio (1752-1832), was an Italian composer best known for his piano music. Clementi was also a successful pianist, conductor, and manufacturer of pianos. His most important composition, *Gradius ad Parnassum* (1817-1826), is a collection of 100 piano studies still used by students to develop their technique. Clementi's works also include more than 60 piano sonatas and almost 40 sonatas for piano and other instruments. His compositions helped establish techniques for playing the piano, which was replacing the harpsichord as the most important keyboard instrument in the late 1700s.

Clementi was born in Rome. At the age of 14, he was taken to England to study music. In 1773, he made his London debut as a pianist and composer. In 1780 and 1781, he toured Europe as a piano soloist. Clementi performed against Wolfgang Amadeus Mozart in 1781 in a test of skill at the court of the Austrian Emperor. From 1782 to 1802, he composed, gave lessons, and performed in London. He toured Europe again from 1802 to 1810. Clementi lived in England from 1810 until his death.

Cleopatra (69-30 B.C.) was a queen of ancient Egypt and one of the most fascinating women in history. She lacked beauty, but became known for her intelligence, charm, wit, and ambition. At times, Cleopatra was ruthless. However, she took a great interest in her subjects' welfare and won their affection. Cleopatra loved and developed loyal relationships with Julius Caesar and Mark Antony, two of the greatest Roman leaders of her day.

Cleopatra was the last ruler in the *dynasty* (series of rulers in the same family) founded by Ptolemy I in 323 B.C. Ptolemy was a general in the army of the Macedonian conqueror Alexander the Great. Cleopatra is also known as Cleopatra VII because she was the seventh Egyptian queen of Macedonian descent with that name.

Cleopatra and Caesar. Cleopatra became queen in 51 B.C. after the death of her father, Ptolemy XII. Her 10-year-old brother, Ptolemy XIII, became her co-ruler and husband. Marriage between a brother and a sister was a common practice in Egyptian royal families.

In 48 B.C., young Ptolemy's guardians seized power for him and drove Cleopatra from the throne. At the same time, Julius Caesar arrived in Alexandria, then Egypt's capital. He came in pursuit of Pompey, a Roman general and rival in Caesar's struggle to become the ruler of Rome. Caesar and Cleopatra met and fell in love.

Caesar defeated Cleopatra's opponents. Ptolemy XIII drowned while trying to escape. Caesar then put Cleopatra back on the throne along with another brother, Ptolemy XIV. In 47 B.C., Cleopatra gave birth to a boy, Caesarion, who she claimed was Caesar's son. In 46 B.C., at Caesar's invitation, she went with Caesarion and Ptolemy XIV to Rome. She stayed there until 44 B.C., when a group of Roman aristocrats assassinated Caesar. After returning to Egypt, Cleopatra had Ptolemy killed so that Caesarion could rule with her.

Cleopatra and Mark Antony. In 41 B.C., Mark Antony invited Cleopatra to Tarsus in Asia Minor (now Turkey). Antony was then one of the rulers of Rome, with Gaius Octavian and Marcus Lepidus. Antony had met Cleopatra when she stayed in Rome as Caesar's guest. Antony wanted to rule Rome alone and hoped to obtain financial aid from Cleopatra. Antony and Cleopatra fell

in love. In 40 B.C., Cleopatra gave birth to twins, Alexander Helios and Cleopatra Selene. Antony loved Cleopatra and their children. But he left them to marry Octavia, the sister of his co-ruler Octavian (see Octavia). The marriage was a wise political move, but Antony missed Cleopatra. He left Octavia, returned to Cleopatra, and, in 37 B.C., married her. A year later, she had another son by him, Ptolemy Philadelphos.

Antony and Cleopatra worked closely to achieve their ambitions. He believed that the wealth of Egypt would help him become the sole ruler of Rome. She wished chiefly to put her children, especially Caesarion, in line to rule Rome. In 34 B.C. Antony appointed Cleopatra ruler of Egypt, Cyprus, Crete, and Syria. He gave his sons and daughter by Cleopatra much of the land once ruled by Alexander the Great. These actions angered Antony's co-rulers and rivals. Octavian regarded Cleopatra as greedy and ambitious, and felt that she had turned Antony into a helpless puppet.

In 32 B.C., Octavian and Antony declared war on each other. In 31 B.C., forces of Antony and Cleopatra lost the Battle of Actium off the west coast of Greece (see Actium, Battle of). Cleopatra and Antony then returned to Alexandria. A few months later, Octavian came after them. In 30 B.C., after Octavian and his forces reached Egypt, Cleopatra spread a report that she had committed suicide. Antony heard the report and stabbed himself out of grief. Before he died, Antony learned that Cleopatra was alive. His followers carried him to Cleopatra, and he died in her arms.

Cleopatra believed that Octavian would publicly humiliate her in Rome. She tried to make peace with him, but failed. In despair, Cleopatra took her life by placing an asp, a poisonous snake, on her chest or arm. After her death, the Romans executed Caesarion because they feared he would claim to be Caesar's heir and the rightful ruler of Rome's empire.

Cleopatra's reputation in history comes largely from the views of Octavian, who described Antony as the lovestruck victim of a wicked temptress. The Roman poets Virgil and Horace also adopted this version. Cleopatra's story has been told many times in literature. It is dramatized in the famous plays *Antony and Cleopatra* (1607) by William Shakespeare, *All for Love* (1677) by John Dryden, and *Caesar and Cleopatra* (1898) by George Bernard Shaw.

See also **Antony, Mark; Augustus; Caesar, Julius; Egypt, Ancient (picture).**
Cleopatra's Needles are two famous obelisks (tall pillars of stone) from



Cleopatra's Needle in London is over 3,000 years old. It was taken to London from Egypt in the 1870s



Cleveland, a leading industrial centre of the United States, lies along Lake Erie. The picture on the left shows buildings in the centre of the city and part of Cleveland harbour, foreground. The harbour is one of the busiest on the Great Lakes. Ocean-going ships sail via the St. Lawrence Seaway from the Atlantic Ocean to Cleveland.

ancient Egypt. One stands on the bank of the River Thames in London. The other stands in Central Park in New York City. The obelisk in London is 20.9 metres tall and weighs 160 metric tons. The one in New York rises 21 metres and weighs 180 metric tons. Egypt gave the obelisks to the United Kingdom and the United States in the 1870's.

Kings of ancient Egypt erected such obelisks as Cleopatra's Needles as monuments to the sun god Re. The kings built the largest of these monuments at Memphis, Heliopolis, and Thebes between 1500 and 1200 B.C.

Cleopatra's Needles bear the name of Thutmose III, who ruled Egypt during the 1400's B.C. They also include markings added by Ramses II, an Egyptian ruler of the 1200's B.C. Cleopatra's Needles originally stood at the temple of Re at Heliopolis. About 10 B.C., the Roman rulers of Egypt moved them to Alexandria to decorate a palace. Scholars do not know why the obelisks became associated with Queen Cleopatra of Egypt.

Clepsydra. See **Water clock**.

Clerestory is an architectural term for the row of windows in a wall that rises above surrounding roofs. The word is most often applied to churches where the clerestory above the main aisles admits light to the interior. Clerestory windows in many cathedrals and churches are made of beautiful stained glass.

See also **Architecture** (Romanesque architecture).

Clergy. See **Minister; Priest; Rabbi; Deacon**.

Clermont was the first commercially successful steamboat. Designed and built by Robert Fulton, it sailed in regular passenger service on the Hudson River, U.S.A. Fulton sailed the wood-burning *Clermont* up the Hudson from New York City to Albany in 1807 on its first trip. Registered as the *North River Steamboat of Clermont*, the ship was generally called the *Clermont*. See also **Fulton, Robert**.

Cleveland (pop. 505,616; met. area pop. 1,831,122) is the second largest city in the state of Ohio and a leading industrial centre of the United States. It lies on the southern shore of Lake Erie, at the mouth of the Cuyahoga River. Cleveland is an important steel producer. The city also ranks as a transportation, medical, and cultural centre of the Midwest.

Moses Cleaveland, a surveyor for the Connecticut Land Company, founded Cleveland in 1796. The village was named after Cleaveland, but a newspaper printer

misspelled the name in 1831 and it has been known as Cleveland ever since.

Cleveland covers 197 square kilometres. The Cleveland metropolitan area covers 3,950 square kilometres. The city's main streets branch out from Monumental Park, commonly known as the Public Square.

About 95 per cent of Cleveland's people were born in the United States. Blacks make up approximately 45 per cent of the population, and almost all the blacks live on the East Side. Other groups include people of German, Hungarian, Italian, or Slavic ancestry.

The Cleveland area's 4,200 factories produce about 30 billion U.S. dollars-worth of goods yearly. About 45 per cent of the city's workers are employed in manufacturing. The production of transportation equipment is Cleveland's chief industry. Cleveland is also an important producer of machine tools.

Cleveland's harbour, one of the busiest on the Great Lakes, handles about 12 million metric tons of cargo annually. Cleveland Hopkins International Airport is in the southwest of the city.

The world-famous Cleveland Orchestra performs in Severance Hall. The city is also the home of the Cleveland Ballet and two opera companies.

The Chippewa, Erie, and Iroquois Indians lived in the Cleveland region before the first white settlers arrived in 1796. During the early 1800's, settlers from New England came to the area.

The development of the car industry during the early 1900's greatly aided steel manufacturing in Cleveland. A trend toward suburban living began in the 1950's, and many white middle-class Clevelanders moved to newly built areas outside the city. Cleveland's population fell from nearly 915,000 in 1950 to about 500,000 in 1990.

Cleveland was a small administrative county in north-eastern England. With effect from 1996, the county was abolished and replaced by smaller unitary authorities.

The River Tees runs across the area and empties into the North Sea. On the banks of the Tees are vast chemical factories and iron and steel plants.

The county of Cleveland was created in 1974. It replaced the former county boroughs of Hartlepool and Teesside and took in part of southeastern Durham and part of northern Yorkshire. Its name came from the Cleveland area of hills and moorland. The name is of Anglo-Saxon origin and means *hill country*.

People and government

Recreation. Middlesbrough is the recreation and cultural centre of the region. It has an archaeological and scientific museum and an art gallery.

Both Hartlepool and Middlesbrough have professional soccer teams. All the towns and larger villages have their own amateur cricket, rugby, and soccer teams. There is a racecourse at Redcar. Fishing and sailing are popular along the coast.

Local customs. Cleveland has a long tradition of witchcraft. Even today, in the moorland and dales, some people tell stories of spells cast by witches.

Local government. Before April 1996 Cleveland was divided into four districts for local government: *Hartlepool* included the northern part of the county; *Langbaugh* took in eastern Cleveland and included Guisborough, Saltburn, and Redcar; *Middlesbrough*; and *Stockton-on-Tees*, which included the western part of the county. The area is policed by the Cleveland Constabulary, with headquarters in Middlesbrough.

Economy

Manufacturing. The Teesside area has the largest concentration of chemical works in the United Kingdom. The area includes Billingham, Middlesbrough, North Ormesby, Stockton-on-Tees, Teesport, and Wilton. The largest chemical works is one belonging to Imperial Chemical Industries (ICI) at Billingham. It produces ammonia for making sulphate of ammonia and other fertilizers, chlorine, sodium carbonate, and nitric and sulphuric acids, used for making plastics.

Oil refineries lie on the north side of the Tees estuary. The refineries distil crude petroleum to produce petrochemicals, which are used as raw materials for chemical works at Billingham and Teesport. A pipeline takes petrochemicals from Cleveland to chemical works in the Merseyside area.

Iron and steel plants stretch along both banks of the River Tees. On the south bank, they stretch from Middlesbrough to Redcar, and on the north bank they stretch from Middlesbrough to Hartlepool. The iron and steel industry developed in the Middlesbrough area because of local deposits of iron ore. But today, its ore comes from Lincolnshire and Northamptonshire, or from overseas. The industry also uses much scrap iron as a raw material. The industry's other raw materials are coal, which comes from the coalfield to the north of Cleveland, and limestone, from the Pennine Hills.

Some of the steel produced in Cleveland is shipped to Sheffield and other towns for the production of finished articles. Other steel is used locally. For example, workers in Stockton-on-Tees use steel to make heavy industrial equipment.

Facts in brief about Cleveland

Largest towns: Stockton-on-Tees, Middlesbrough, Hartlepool.

Area: 585 km².

Population: 1991 census—541,100.

Chief products: *Manufacturing and processing*—chemicals, electrical goods, engineering goods, iron, plastics, steel.

Mining—coal, potash. *Agriculture*—dairy cattle, oats, potatoes, swedes, turnips.

Hartlepool's industries include electrical engineering, shipbuilding, steelworks, and works producing pipes. The town has a fishing quay and extensive docks that handle imported timber and iron ore. Hartlepool is a base for the North Sea gas industry.

Agriculture. Farmers near the towns rear dairy cattle. In other parts of Cleveland, they rear beef cattle. Many farms have some sheep, pigs, or poultry. The main crops are oats and root vegetables, most of which are used for feeding animals. In the Tees valley, farmers produce potatoes, swedes, and turnips.

Mining. A coalfield stretches northwards from the Hartlepool area, across the counties of Durham and Tyne and Wear. Hartlepool's docks export coal. Much of the iron ore deposits in the Cleveland Hills has been worked out. But some is still produced at Skinningrove, near Brotton.

Local deposits of chemicals such as salt led to the development of Cleveland's chemical industry. At Great-ham, a salt bed lies 300 metres below ground. Workers extract the salt by pumping in water to dissolve it. The brine (saltwater) is pumped up and refined at local works. Nearby are large potash deposits.

Tourism. The Cleveland area has three popular holiday resorts, all with good beaches. These resorts are Marske-by-the-Sea, Redcar, and Saltburn. Redcar is noted for its particularly good amusement and recreational facilities.

Transportation and communication. Docks are important in Cleveland. The main ports are Hartlepool and Middlesbrough, which import raw material for industry. General cargo in containers travels between Middlesbrough and Rotterdam in the Netherlands.

A network of roads runs across the region. But road communications westward across the Pennine Hills are poor. Middlesbrough's transporter bridge carries traffic over the River Tees.

A main railway line links the area with York, to the south, and Newcastle upon Tyne, to the north. The line



Cleveland was a small industrial county in northeastern England. The region borders the North Sea.



The transporter bridge at Middlesbrough, Cleveland carries road vehicles on a moving platform across the River Tees

runs through Stockton-on-Tees, Middlesbrough, and Hartlepool.

A BBC local radio station, Radio Cleveland, is sited in Middlesbrough. Tfm Radio, an independent station, operates from Stockton-on-Tees. Daily newspapers are published in Hartlepool and Middlesbrough.

Land

Location and size. Cleveland is a small region, bounded by Durham to the north and west, by North Yorkshire to the south, and by the North Sea to the east. Its maximum measurement from north to south is only about 27 kilometres. From east to west, its maximum measurement is about 42 kilometres.

Land features. The Cleveland Hills lie in the southern part of the region. Their highest point is Roseberry Topping, which reaches 317 metres above sea level. Near Hartlepool and south of Saltburn, the coast is lined with cliffs.

Rivers. The River Tees flows across Cleveland from west to east. In recent years, dredgers have worked to widen and deepen the river for oil tankers. South of Hartlepool, at Teesmouth, there are great marshes and areas of flat sand.

Climate. Cleveland has a changeable climate, but relatively low rainfall. Coastal fogs are quite common. The warmest month is July, which has an average temperature of about 16 °C. January is the coldest month, with an average of 4 °C.

Cleveland is sheltered from rain coming from the west by the Pennine Hills. The Cleveland Hills are the rainiest part of the region. In most parts of the region, average annual rainfall is less than 625 millimetres.

History

In prehistoric times, Cleveland was an area of forest and moorland. Few people lived there. The Romans had little effect on the area. The Angles gradually cleared the trees from the forest lowlands and developed farms.

Soon after the Norman conquest, Robert de Bruce became lord of the manor at Hartlepool. In the late 1100's, a fleet of crusaders' ships made use of the harbour at Hartlepool. In 1200, King John granted the town a *charter*, giving it various rights and privileges. During the 1300's, Hartlepool was a leading military port and a substantial town. During the English Civil War, it was captured by Scottish troops. Hartlepool declined after that, and by the 1700's, was just a fishing village.

Coal mining started in the Cleveland area in the 1300's. The development of the mining industry led to the growth of Stockton-on-Tees. During the 1800's, Cleveland developed rapidly. George Stephenson opened the first public railway using steam locomotives in 1825. It ran from Stockton-on-Tees to Darlington.

With effect from 1996, the Cleveland County Council was replaced by four unitary authorities based on the former local districts.

Related articles in *World Book* include:

Chemical industry	Middlesbrough
Hartlepool	Stockton-on-Tees
Iron and steel	

Cleveland, Grover (1837-1908), was president of the United States for two separate terms. He was the first Democratic president elected after the American Civil War (1861-1865). The emotions of the war had cooled enough to permit the return to a two-party system. Cleveland's victory also was a protest against the waste and corruption that had disgraced Republican administrations after the war. His honesty helped restore confidence in the government.

Stephen Grover Cleveland was born in Caldwell, New Jersey. When he was 17, he moved to Buffalo, in the state of New York, where he studied law. He was admitted to the bar in 1859. In 1881, Cleveland was elected mayor of Buffalo. In 1882, he won election as governor of the state of New York. In 1884, Cleveland defeated James G. Blaine, the Republican candidate, in the presidential election.

First administration (1885-1889). Cleveland, who faced a Republican Senate, made effective use of the presidential powers of veto, appointment, and administrative control. Among the most important issues facing Cleveland during his first term was the question of *tariffs* (taxes on imports). Industrialists wanted a high tariff to protect high prices. Farmers, however, who were burdened with heavy debts, wanted a low tariff so they would not have to pay high prices for imported manufactured goods. Cleveland felt that tariffs should be reduced, mainly because the government was collecting more money than it spent. But he failed to persuade Congress to reduce them.

In the 1888 presidential election, Cleveland was defeated by Benjamin Harrison. Cleveland ran against Harrison again in 1892 and won a second term.

Second administration (1893-1897). Cleveland's most popular action during his second term was his firm stand in a dispute between the United Kingdom and Venezuela over the boundary between Venezuela and British Guiana (now Guyana). After Cleveland hinted that armed force might be necessary to settle the matter, the UK agreed to submit the Venezuela boundary to international arbitration, and a settlement was reached. But historians have criticized Cleveland's intervention as extreme and provocative. At home, a business slump and labour disputes dogged his second presidency. A rail strike in 1894 led to riots. Cleveland used troops to restore order. Cleveland did not seek a third term as president. He retired to Princeton, New Jersey.

Cleveland Hills are a group of hills bordering on the counties of North Yorkshire and Cleveland in northern England. They are the northern and northeastern part of the moorland plateau that forms the North York Moors National Park. Much of the Cleveland Hills has a wild scenic beauty.

Cleves, Anne of. See *Kings and queens of Britain and Ireland (The Tudors)*.

Cliburn, Van (1934-), is an American concert pianist. He chiefly performs works written by romantic composers of the 1800's and 1900's, including Johannes Brahms, Frédéric Chopin, Franz Liszt, Sergei Rachmaninoff, Robert Schumann, and Peter Ilich Tchaikovsky.

Cliburn was born in Shreveport, Louisiana. His full name is Harvey Lavan Cliburn, Jr. His mother began teaching him to play the piano when he was 3 years old. Cliburn studied piano at the Juilliard School in New York City from 1951 to 1954. He made his concert debut in Houston, Texas, in 1947 but did not begin an active concert career until 1954. Cliburn gained worldwide recognition in 1958, when he won the International Tchaikovsky Piano Competition in Moscow.

Click beetle is the name used for any one of a group of beetles that spring and snap. There are about 7,000 different kinds of click beetles. Most of them are brown, but some are black, grey, or marked with bright colours.

The young of the click beetle are long, slender worms called *wireworms*. Wireworms bore into seeds of young maize, wheat, and other grains. They also feed on the roots of field and garden plants. Wireworms live in decaying wood.

Some click beetles found in tropical regions can glow in the dark. One kind has two glowing spots on each side of its body. See *Beetle (Kinds of beetles)*.

Scientific classification. Click beetles make up the click beetle family, *Elateridae*, in the order Coleoptera.

See also *Wireworm (with picture)*.

Cliff is a steep face of rock. Many processes of erosion form cliffs. Waves cut imposing and scenic cliffs along coastlines. Rivers create deep canyons and gorges with steep sides. Glaciers grind away the rock along valley walls and produce cliffs that appear after the glacier melts. Glaciers also pluck rock fragments away from high mountain slopes where snow collects to form walls around amphitheatrelake basins.



Sheer cliffs of solid rock rise from the waters of Dingle Bay on the western coast of the Republic of Ireland.

Clifford, Sir Hugh (1866-1941), was a pioneer British administrator in Malaya. His sympathetic insight into the culture of that region made a significant contribution to Malay studies.

Hugh Charles Clifford was born in London, and at the age of 17 went to Singapore as a cadet in the Straits Settlement Civil Service. From 1896 to 1899, he was British *resident* (government representative) in Pahang. He then served in various other British colonies, receiving a knighthood in 1909. Clifford returned to Malaya in 1927, as high commissioner for the Malay States. In 1929, he resigned and went back to England permanently because of his wife's ill-health.

Sir Hugh wrote a number of short stories in English which displayed his deep understanding of Malay culture. These stories included *In Court and Kampong* (1897), *Studies in Brown Humanity* (1898), and *In a Corner of Asia* (1899).

Cliffs of Dover. See *Dover*.

Climate is the sum of all weather events in an area during a long period of time. *Climatologists* (scientists who study climate) often describe the climate in terms of an area's average monthly and yearly (1) temperatures and (2) amounts of *precipitation*. Precipitation consists of rain, snow, hail, and other forms of moisture that fall to earth. Climatologists also describe the year-to-year changes that produce major wet and dry spells.

Climate and weather are not the same. Weather is the condition of the atmosphere during a brief period. The weather may change from day to day. One day's weather may be stormy, wet, and cool. The next day's may be sunny, dry, and somewhat warmer. To determine the climate of an area, scientists study the daily weather conditions over many years.

Every place on the earth, no matter how small, has its own climate. Places that lie far apart may have a similar climate. Yet there may be important differences between the climate of a hill and a nearby valley, or of a city and the surrounding countryside.

The Importance of climate

Climate affects the way of life of people no matter where they live. For example, it influences the kinds of clothing people wear and the kinds of foods they grow and eat. It also influences the types of homes they live in and the types of transportation they use. In addition, climate helps determine the kinds of plants and animals that can live in an area.

Clothing and climate. People wear clothing that protects them against the climate of their area. In warm regions, people wear clothes made of a lightweight material, such as cotton or linen. Much of the clothing in warm regions is white or light-coloured because these colours reflect the sun's rays. In cold regions, people wear heavy clothing made of such materials as fur or wool. People of the Arabian deserts wear loose, flowing robes that protect them from both the hot days and the

cold nights of the desert. In regions that have cold winters and warm summers, people wear heavy clothing in the winter and light clothing in summer.

Food and climate. Most food crops grow best in areas that have a certain climate. A mild, fairly dry climate is best for growing wheat. Rice thrives in a warm, rainy climate. Many orchards are planted on a hillside, rather than in a nearby valley. Frost, which may damage fruit, occurs more often in valleys than on hillsides.

Housing and climate. Homes provide protection against the climate. People who live in an area with a hot season and a cold season build sturdy, well-insulated housing that keeps out both heat and cold. In hot, dry regions, people build houses with extra-thick walls that keep out the heat. In rainy places, houses may have a steep, pointed roof so that rain can run off easily.

Transportation and climate. In many places, the climate helps determine the kind of transportation that people use. For example, the people who live near the equator in west-central Africa travel largely by boat along the rivers. This area has a hot, wet climate, and so plants and trees grow quickly. The heavy rains and thick forests hamper the construction and maintenance of roads and railways. People who live in cold, snowy areas often use skis, sleds, or snowmobiles for transportation.

Animal life and climate. Certain animals have adapted to life in certain climates. For example, camels live in the hot, dry deserts of Africa and Asia. These animals can go without water for days or even months. Crocodiles are found in rivers, swamps, and marshes in hot regions, including parts of Central America. Polar bears live in the Arctic, and penguins live in Antarctica. Both the Arctic and Antarctica have an extremely cold climate.

Plant life and climate. Plant life also varies with climate. Cactuses grow chiefly in areas that are hot and dry. These plants differ greatly from the evergreens that

How climate affects ways of life



Cool autumns are part of the *continental moist* climate of New England, U.S.A. A tightly built house keeps out cool air. Many people frequently wear a light coat for warmth outdoors.



Long, cold winters are common in areas of Alaska with a *polar* climate. Sturdy wooden homes provide protection from the cold, and people wear clothing of such materials as fur or wool.

are found in cold northern regions. The beech and maple forests that thrive in the climate of the New England region in the northeastern United States differ from the grasslands of the Midwestern United States. Tall trees grow in the warm, rainy climate of many regions near the equator. But only mosses and other small plants can live in the extremely cold areas near the North and South poles.

Describing and classifying climates

The scientific study of climate is called *climatology*. In describing the climate of a certain place, a climatologist considers a number of characteristics of the atmosphere. The most important of these characteristics are temperature, precipitation, humidity, sunshine and cloudiness, wind, and air pressure.

Climatologists begin by describing the climate in terms of average temperature and precipitation amounts. They also consider the variations that occur between the different seasons of the year. For example, the average yearly temperature in both St. Louis and San Francisco in the United States, two cities in similar latitudes, is about 13° C. Yet these two cities have different climates. St. Louis, which stands on the Mississippi River in the Interior Plains, has fairly cold winters and hot summers, with precipitation all the year around. San Francisco, on the Pacific Ocean coast, has mild, rainy winters, and cool, almost rainless summers.

Climatologists have developed various systems of climatic classification. However, many of these experts recognize 12 major kinds of climate: (1) tropical wet, (2) tropical wet and dry, (3) highlands, (4) desert, (5) steppe, (6) subtropical dry summer, (7) subtropical moist, (8) oceanic moist, (9) continental moist, (10) subarctic, (11) polar, and (12) icecap. The world map with this article shows the locations of these climates. But the map does not indicate the differences within each major kind of climate. For example, two coastal cities, Sydney, Australia, and

Wellington, New Zealand, have the same general kind of climate—subtropical moist. That is, these cities generally have warm to hot summers and cool winters, with moderate precipitation in all seasons. However, there are a number of differences between the climate of the coast of southeastern Australia and the coast of North Island, New Zealand.

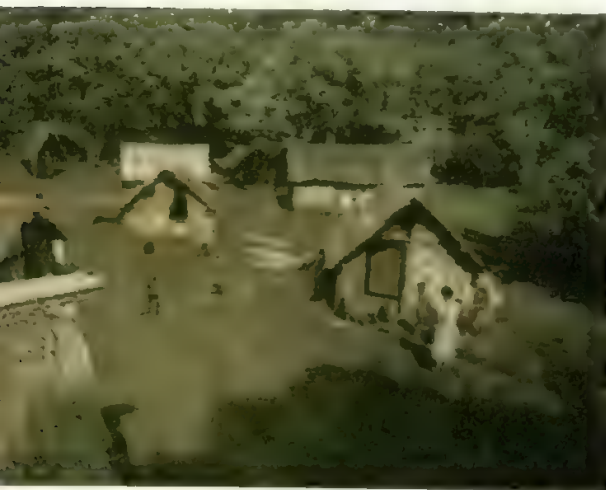
Why climates differ

In addition to describing and classifying climates, climatologists try to learn why the climate of one place is different from that of another. They have determined that climates differ for a number of reasons, including (1) differences in latitude, (2) differences in the availability of moisture, (3) differences in land and water temperatures, and (4) differences in the land surface.

Differences in latitude affect climate in a number of ways. Most importantly, places at different distances from the equator receive different amounts of energy from the sun. This energy difference occurs because the position of the sun in the sky varies with latitude. In *tropical* areas close to the equator—that is, areas between the Tropic of Cancer and the Tropic of Capricorn—the sun shines almost directly overhead throughout the entire year. These direct rays are an intense source of energy, and so they produce high temperatures. Most regions near the equator have a hot or warm climate. See *Tropic of Cancer*; *Tropic of Capricorn*.

The sun never rises far above the horizon in areas near the North and South poles—north of the Arctic Circle and south of the Antarctic Circle on the map. Because the sun is low in the sky, its rays are slanted. Slanted rays shine less intensely than direct rays do, and so they produce lower temperatures. Therefore, the regions near the poles generally have a cold climate. See *Antarctic Circle*; *Arctic Circle*.

Locations in the *middle latitudes* tend to have temper-



In Vanuatu, many houses have a thatch roof to keep rain from dripping in. This southwest Pacific island nation has a *tropical wet* climate. Many of the people wear little clothing



People of the Sahara, including these Tuareg women, wear loose-flowing garments. Such clothing protects them from the heat and the cold of a *desert* climate. Their tent provides shade

atures that average between those of equatorial and polar areas. The middle latitudes lie between the Arctic Circle and the Tropic of Cancer in the Northern Hemisphere, and between the Antarctic Circle and the Tropic of Capricorn in the Southern Hemisphere. Middle latitude locations receive more direct, higher intensity sunlight in the summer and less direct, lower intensity sunlight in the winter. Longer periods of sunlight during summer days and shorter periods during winter days increase the effects of these seasonal differences on temperatures. Thus, summers are warm and tropical, and winters are cold.

Places at different distances from the equator are also affected by different wind systems. Winds result from the uneven heating of the air around the earth. Air heated by the sun expands and rises, and cooler air flows to take its place, producing belts of prevailing winds. Prevailing winds in tropical areas blow from east to west. Winds in the middle latitudes tend to blow from west to east, but these winds and the winds near the poles are highly variable in direction. Because winds transport heat and moisture, they affect an area's temperature, humidity, precipitation, and cloudiness. As a result, areas with different prevailing wind directions may have different climates. See *Wind*.

Differences in the availability of moisture also affect climate. The air absorbs the greatest amount of moisture from warm parts of the ocean near the equator. Wind systems carry this moisture to the land where it may fall to the ground as precipitation. As a result, most of the wettest places in the world are near the equator or in locations where the prevailing winds blow inland from the ocean. On the other hand, little precipitation occurs in polar regions, where water temperatures are cold. In addition, little precipitation occurs in areas that are long distances from an ocean.

Differences in land and water temperatures. In spite of the importance of latitude in determining climate, two places at the same latitude may have different climates. This situation may occur if one place is in the inland area of a continent and the other is in a coastal area. Water heats and cools more slowly than land does. In summer, bodies of water do not become as warm as the land, and in winter they do not become as cold. As a result, the inland area of a continent may be warmer in summer than the coast, which is cooled by the ocean air. In winter, the inland area of a continent may be colder than the coast, which is warmed by the ocean air. A large lake may have similar effects on nearby land.

Bergen, a city on the southwest coast of Norway, lies about 2,115 kilometres north of the city of Omaha, Nebraska, in the heart of the United States. Because Bergen is farther from the equator than Omaha is, the Norwegian city might be expected to have a colder, drier climate. But ocean air warmed by the North Atlantic Drift (a northward extension of the warm Gulf Stream) gives Bergen an average January temperature that is higher than the average January temperature in Omaha. Ocean air also keeps Bergen's average July temperature lower than Omaha's. Moist ocean winds bring a yearly average of 205 centimetres of precipitation to Bergen. Omaha receives a yearly average of 65 centimetres.

Differences in the surface of the land result in many differences among climates. For example, as air

rises and expands, its temperature becomes colder. Cold air cannot hold as much moisture as warm air can. Therefore, air that rises to pass over a mountain becomes colder and may lose much of its moisture. As a result, a place located on a mountain generally has a cooler, wetter climate than does a place at a lower elevation. Mountain slopes that face moist ocean winds have especially heavy precipitation.

Places in hilly or mountainous regions have a *highlands* climate. This kind of climate cannot be defined exactly. Nearby places in a highlands region may have somewhat different climates if they lie (1) at different elevations, or (2) in different positions relative to the prevailing winds.

Mountains may have major effects on the climate of nearby lowland areas. For example, the moist westerly air streams that blow over the British Isles shed much of their moisture on the highlands in the west. By the time the winds reach the low-lying eastern parts of Britain, the air is warmer and drier. In general, more than 200 millimetres of rain falls in the upland areas of Ireland and Britain, while less than 760 millimetres falls in the eastern lowlands.

Differences in climate may occur even within a small, fairly level area. Such differences result from small differences in the surface of the land. In the Northern Hemisphere, gently sloping land that faces north has a somewhat cooler climate than does a slope that faces south, toward the equator. Also, the centre of a large city is generally warmer than the surrounding region. Cars and the heating systems of buildings produce a large amount of heat in the city. In addition, such surfaces as pavements and the walls of buildings absorb much energy from the sun and thus heat the lower air.

The changing climate

Changes in climate take place slowly through the years. For example, the climate of many areas of North America was somewhat colder in the 1960's and early 1970's than in the 1930's and 1940's. This change formed part of a worldwide cooling pattern that began in the late 1940's. Yet the climate of North America is much warmer today than it was about 15,000 years ago. At that time, glaciers covered much of what is now Canada and the northern United States.







Climatologists believe there may be a number of causes of climatic change. One cause might be a change in the amount of energy given off by the sun or in the earth's orbit around the sun. Such changes may produce a variation in the amount of heat received from the sun. Another cause of climatic change may be *volcanic dust*. When a volcano erupts, it throws huge amounts of this dust into the atmosphere. The dust may stay in the air for many years, scattering the sun's rays and reducing the amount of sunlight that reaches the ground. Thus, a volcanic eruption may have cooling effects. Agricultural and industrial activity also causes large amounts of particles to be discharged into the air. These particles may have effects similar to those caused by volcanic dust.

Another cause of climatic change may be carbon dioxide, a gas that occurs naturally in the atmosphere. Carbon dioxide is also produced by burning. Since about 1900, the amount of carbon dioxide in the atmosphere has increased considerably because people have

What the world's climate is like



Source: Map by Edwin H. Hammond. Adapted from *Physical Elements of Geography* 5th edition by Trewartha, Robinson & Hammond.

- | | | | |
|--|--|---|---|
|  | Tropical Wet —Always hot, always wet. Heavy precipitation well distributed throughout the year. |  | Desert —Hot to cold, with great changes in daily temperature except in coastal areas. Very little precipitation. |
|  | Tropical Wet and Dry —Always hot, with alternate wet and dry seasons. Heavy precipitation in the wet season. |  | Steppe —Hot to cold, with great changes in daily temperature except in coastal areas. Little precipitation. |
|  | Highlands —These areas are affected by altitude and are generally cooler and wetter than the adjacent climates. |  | Subtropical Dry Summer —Hot, dry summers and mild, rainy winters. Moderate precipitation in winter. |

burned large amounts of fuel in their homes and in factories. Carbon dioxide allows sunlight to reach the earth and warm its surface, but it prevents some surface heat from escaping out of the atmosphere. This *greenhouse effect* may raise the temperatures near the ground.

Although a general cooling of the earth's climate has occurred since the 1940's, some areas have become warmer. In addition, some areas have become wetter, and others have become drier. Climatologists do not know exactly why these changes have taken place. Nei-

ther do they know which changes form part of a natural pattern and which ones, if any, have been caused by people. Some climatologists believe temperature variations caused by increased carbon dioxide or particles in the air may have brought changes in the earth's wind systems. Such changes, in turn, may have caused various kinds of climatic changes.

Climatologists want to learn why climatic changes occur, chiefly because some of these changes could hurt food production. Knowledge of what is involved in



such climatic changes may help scientists prepare for them.

Related articles. See the section on *Climate* in the various state, province, country, and continent articles, such as *Australia (Climate)*. See also *Weather* and its list of *Related articles*. Other related articles in *World Book* include:

- Acclimatization
- Animal (Where animals live)
- Arctic (Climate)
- Biome
- Clothing (Protection)
- Desert
- Drought
- Food (Geographical reasons)

- Greenhouse effect
- Gulf stream
- Ice Age
- Icecap
- Isotherm
- Lake (Climate)
- Latitude
- Meteorology
- Ocean (As an influence on climate)
- Phenology

- Plant (Where plants live)
- Races, Human (Climatic adaptations)
- Rain
- Season
- Shelter (Climate)
- Snow
- Temperature
- Tropics
- Wind

Climatology. See Climate.

Clinical psychology is the scientific study, diagnosis, and treatment of people who have psychological problems adjusting to themselves and the environment. Clinical psychologists deal with both normal and abnormal behaviour. They administer and interpret psychological tests, and assist in the diagnosis and treatment of mental disorders. They also study the structure and development of personality.

Clinical psychology is a scientific and *applied* field of psychology. That is, it puts into practice the theories developed in the different fields of psychology. For example, clinical psychologists apply many findings of abnormal psychology when they diagnose and treat mental disorders. They also draw knowledge from the fields of learning, motivation, perception, personality, developmental psychology, physiological psychology, and social psychology. Clinical psychologists work in government, hospitals, clinics, universities, and private practice. Their chief activities are (1) testing and diagnosis, (2) psychotherapy and consultation, and (3) research.

Testing and diagnosis. Clinical psychologists develop, administer, and interpret tests that measure aptitude, intelligence, and personality. These tests can be used in diagnosing mental disorders. Sometimes they are used to help determine proper placements for people in schools and jobs. See **Testing**.

Psychotherapy and consultation. Clinical psychologists treat mental disorders that result in disturbed human relationships or individual anxiety or unhappiness. They deal with brief, minor disturbances such as stress resulting from a school failure or grief due to the loss of a loved one. They also try to solve the prolonged problems of internal emotional conflicts often called *neuroses* and of *psychoses*. Psychoses are problems in which a person's thoughts, feelings, words, or perceptions are severely unrealistic.

Psychotherapy is the clinical psychologist's chief tool in treating mental disorders. In most kinds of psychotherapy, the psychologist talks with the patient in a series of informal interviews. In most cases, the psychologist tries to help the patient understand the cause of the patient's personality disturbance (see **Mental illness** [Methods of treatment]).

Understanding and preventing mental disorders is an important goal of clinical psychologists. They develop and take part in consultation programmes to educate the public in methods of improving child care and relationships and expanding mental health facilities. They also work with the clergy, teachers, and others who deal with children to help identify and solve psychological problems that develop at an early stage.

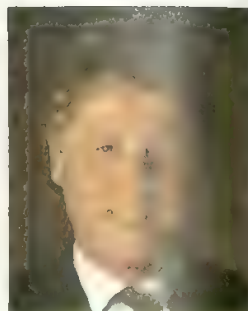
Research. Clinical psychologists are trained to design and conduct scientific experiments. Through their knowledge and use of research techniques, they improve various methods of diagnosing and treating mental disorders. They propose and test new theories on the structure and development of personality. They also develop and evaluate new testing and treatment methods.

Clinker. See Cement and concrete (How cement is made).

Clinker-built vessel. See Ship (Viking ships; illustrations).

Clio. See Muses.

Clinton, Bill (1946–), was elected president of the United States in 1992. Clinton, a Democrat, won the election while serving his fifth term as governor of Arkansas. In the presidential election he and his running mate, Senator Al Gore of Tennessee, defeated President George Bush, the Republican candidate, and Vice President Dan Quayle.



Bill Clinton

Clinton took office at a time when U.S. interests had shifted sharply from foreign affairs to domestic issues. The collapse of the Soviet Union in 1991 had brought the Cold War to an end. By 1992, Americans were concerned about a decline in U.S. productivity and signs of growing racial tensions, crime, and poverty in U.S. cities. During his campaign, Clinton promised to reduce the need for deficit spending and to expand the educational and economic opportunities of poor and middle class Americans.

William Jefferson Clinton was born in Hope, Arkansas. His father, William Jefferson Blythe III, was killed in a car crash three months before he was born. He took his stepfather's name, Clinton, when he was 15. Clinton was educated at Georgetown University and spent two years at Oxford University, England, as a Rhodes Scholar. In 1972, he graduated from Yale Law School. He was elected attorney general for Arkansas in 1976. He was first elected governor in 1978. In 1980, he failed to win reelection, but was returned to office for four subsequent terms. At 46, Clinton was the second-youngest person ever to be elected president. He is married with one daughter.

Clipper ship was a fast, slender sailing vessel that was developed in the United States in the mid-1800's. To be classed a clipper, a ship needed a narrow *hull* (body) that was deeper at the back than at the front, and many



Oil painting (1888) by Frank Vincent Smith, Mariners' Museum, Newport News, Virginia, U.S.A.

The *Cutty Sark*, above, was one of the most famous clipper ships. The slender hulls and many sails of the graceful clippers made the ships the fastest vessels of the mid-1800's.

large sails mounted on tall *masts* (sail poles). Clipper ships were modelled after the "Baltimore Clippers," small, swift sailing ships developed for sea use. The name *clipper* came from the way the ships "clipped off" the miles. Clipper ships carried tea and opium from China, and wool and gold from Australia. They carried passengers across the Atlantic Ocean.

The *Rainbow*, designed by John W. Griffiths and launched in 1845, was the first true clipper ship. It was much larger and faster than the earlier "Baltimore Clippers." British shipbuilders began building clipper ships in 1855. Their most famous vessels were the *Thermopylae* and the *Cutty Sark*.

Perhaps the most famous builder of clipper ships was Donald McKay, a Canadian. His ships included the *Flying Cloud*, *Stag Hound*, *Lightning*, *Sovereign of the Seas*, and *Great Republic*. When it was launched in 1853, the *Great Republic* was the largest sailing ship in the world. It measured about 100 metres long.

Some typical, fast clipper trips included a voyage across the Atlantic Ocean in 12 days, 6 hours by the *James Baines*; and a run of 748 kilometres in 24 hours by the *Champion of the Seas* in 1854. More than 25 years passed before a steamship beat the *Champion of the Seas* record. The opening of the Suez Canal between the Mediterranean and Red seas in 1869 did away with the need for clippers for the tea trade. Many clippers began carrying wool from Australia, but in this trade, speed was not essential. Thus, in the late 1800's, *square-riggers* (ships designed to carry larger cargoes at slower speeds) gradually replaced the clipper ships.

See also *Cutty Sark*; *Ship* (Clipper ships).

Clive, Robert (1725-1774), was the British administrator and military leader who brought India into the British Empire. Clive was born in Shropshire, England. He joined the English East India Company, Britain's trading company in India, in 1743. In 1747, he received a com-

mission in the company's armed services. The British and French were struggling for control of India, and Clive won several important victories over the French and their Indian allies. In 1757, he led 3,200 troops to victory over 50,000 enemy troops at the Battle of Plassey, giving Britain control of the rich province of Bengal.

Clive returned to England in 1760 and entered Parliament. He was created Baron Clive of Plassey in 1762. In 1773, some of Clive's enemies persuaded Parliament to investigate his career in India. The investigation showed that Clive had made a fortune, but that he had also rendered "great and meritorious service to his country." Sickness during the last year of his life caused Clive to become an opium addict. He committed suicide in 1774. **Clock** is an instrument that shows the time. Clocks not only measure and tell time but also serve as decorations in homes and other buildings.

The first clocks were probably developed in the late 1200's. They had no hands or dial but told the time by ringing a bell. The word *clock* probably comes from the French word *cloche* and the German word *Glocke*, both of which mean *bell*.

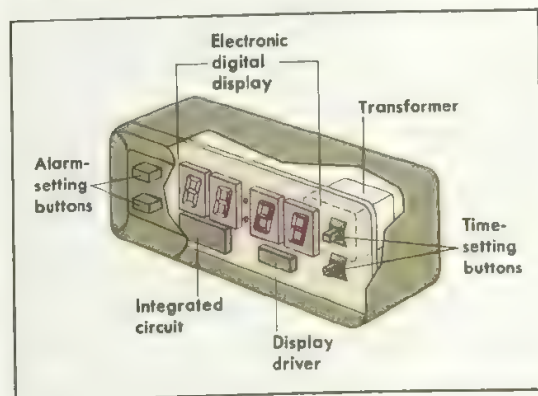
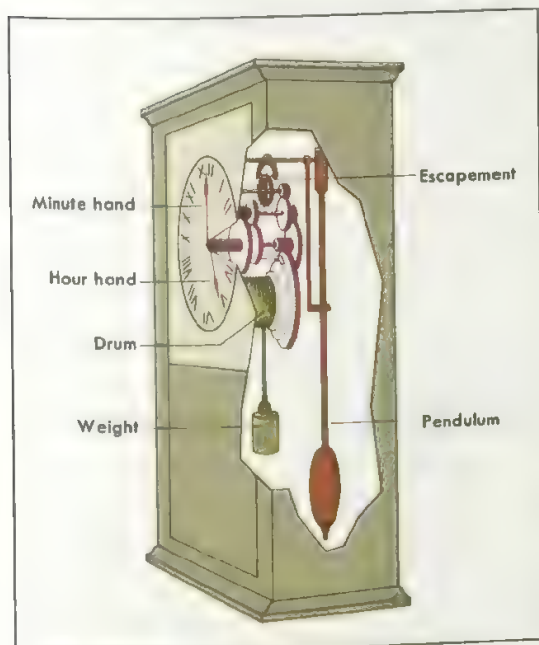
Kinds of clocks

Modern clocks range from small, inexpensive models to large, ornamental grandfather clocks with beautiful wood cases and complex chimes. Traditional clocks, called *dial clocks*, have hands that show the time by pointing to numbers on a dial. Other clocks, called *digital clocks*, show the time in digits on the clock face. Many clocks have chimes or sound an alarm.

Every clock has two main parts, the *case* and the *works*, or *movement*, inside the case. The works perform three functions. In addition to showing the time, it supplies power to run the clock and it keeps time. Clocks differ according to how their works carry out one or more of these three functions. This article classi-

A weight-driven clock, left, is powered by a weight that is lowered from a drum, *shown in green*. As the weight descends, the drum revolves and turns gear wheels, *pink*, that move the hands. The pendulum and escapement, *orange*, control the clock's speed.

A line-powered digital clock, below, is powered by an alternating electric current. The current flows through the transformer to the integrated circuit, which changes the current's frequency into timed electric impulses. The display driver makes these impulses strong enough to run the electronic display.



Some historical clocks



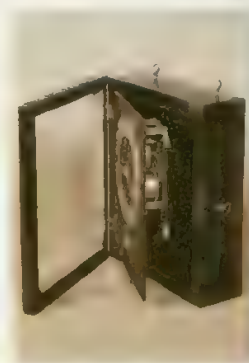
A sundial uses the sun's motion across the sky to tell time. The sun casts a shadow that moves across the dial and points to the hours. This sundial is from the 1100's B.C.



Early portable clocks were powered by a coiled mainspring. Many such clocks had a separate cover, *above left*. This clock was made in France during the mid-1500's.



Early mechanical clocks were weight driven and had only one hand. Some had a bell that struck the hours. This clock was made in Germany during the late 1400's.



Pendulums for clocks were developed during the mid-1600's. These devices greatly improved timekeeping accuracy. This Dutch pendulum clock dates from the 1650's.

fies clocks into two groups, *mechanical clocks* and *electric clocks*, according to how they are powered.

Timekeeping in most clocks is based on the frequency of some regularly repeated action, such as the swing of a pendulum. Clocks with extremely stable frequencies keep time more accurately than those with less stable frequencies. For example, the operation of atomic clocks, the most accurate clocks ever made, is based on the vibrations of certain atoms and molecules. Each of these particles has a natural, characteristic frequency that is extremely stable. As a result, the best atomic clocks do not lose or gain more than a second in 250,000 years.

Mechanical clocks are powered by various mechanical devices that must be wound at various intervals. Some have to be wound every day, but others can run for seven or eight days without rewinding. There are two main kinds of mechanical clocks, *weight driven* and *spring driven*. Almost all of them are dial clocks.

Weight-driven clocks are powered by a heavy weight

that hangs from a cord or chain. When the clock is wound, the cord or chain gets wrapped around a drum and draws the weight up near the drum. As gravity pulls the weight down, the cord or chain slowly unwinds and turns the drum. This action of the drum turns a number of gear wheels that are connected in a series called the *train*. The hands of the clock are attached to individual wheels in the train. Each of these wheels turns at a specific speed. A pendulum and a mechanism called the *escapement* prevent the weight from being lowered too fast. The pendulum and the escapement also regulate the clock's speed.

The escapement includes an *escape wheel* and a *verge*. The escape wheel is connected to the train and turns when the clock runs. The pendulum, which is the timekeeping device of the clock, swings from side to side at a steady rate. As the pendulum swings, it tilts the verge from side to side. With each tilt, two hooks called *pallets*—one at each end of the verge—catch on the escape wheel and stop it. When the pendulum swings back, the pallets release the wheel, and the wheel turns slightly. This process regulates the speed of the escape wheel and of the wheels in the train. It also causes the tick-tock sound of the clock.

Spring-driven clocks contain a coiled spring called the *mainspring*. This spring gets wound up when the clock is wound. Then the mainspring unwinds slowly, turning the wheels in the train. Some spring-driven clocks also have a battery that automatically rewinds the mainspring before the spring runs down.

The escapement in a spring-driven clock resembles that of a weight-driven clock. However, many spring-driven clocks have a *balance wheel* instead of a pendulum as the timekeeping device. A coiled spring called the *balance spring*, or *hairspring*, is connected to the balance wheel. This spring coils and uncoils and makes the balance wheel swing back and forth at a fixed rate. The swinging motion causes the verge to tilt. The pallets alternately catch and release the escape wheel and regulate the speed of the train.

Electric clocks can be *battery powered* or *line powered*. A line-powered clock receives power from an electric outlet. Almost all digital clocks manufactured since the 1930's have been electric models.

Battery-powered clocks. Many battery-powered clocks have a balance wheel or a pendulum that regulates their speed. Others have a miniature tuning fork or a tiny bar of quartz crystal. The battery activates the tuning fork or crystal, which vibrates with high, steady frequencies. In clocks with a tuning fork, an *indexing mechanism* changes the number of vibrations into the correct speeds for the gear wheels. Quartz-based clocks contain a complex electric circuit that translates the number of vibrations into time information. The circuit also controls the time display. Most quartz-based clocks are accurate to within 60 seconds a year.

Line-powered clocks. In line-powered clocks, the current from the electric outlet not only supplies power but also regulates the clock's speed. The flow of alternating current reverses its direction 120 times every second (see *Electric current* [Direct and alternating current]). A motor or an integrated circuit counts the changes in direction and uses that information to control the time display.

Most digital clocks are line powered. In some, the digits are printed on flip cards, rotating drums, or a moving tape. Other line-powered models and some quartz-based clocks have electronic digital displays. These displays include such types as a *liquid crystal display (LCD)* and a *light-emitting diode display (LED)*. A liquid crystal display uses digits that reflect the light around it. A light-emitting diode display has digits shaped from electronic devices called *diodes*, which give off light.

History

Prehistoric peoples probably told the time of day by watching shadows cast by the sun. As the sun moved across the sky, the lengths of the shadows changed. When the shadows were short, the watchers knew the time of day was near noon. Long shadows meant that the day was either beginning or ending.

Sundials, which were developed more than 4,000 years ago, are the oldest known instruments designed for telling time. As the sun crosses the sky, it casts a shadow on the dial. A sundial tells time by measuring the length or the angle of the shadow. See *Sundial*.

Other early timekeeping devices included hourglasses and water clocks. In these devices, sand or water flowed from one container into another at a steady rate. By measuring the material in either container, people could tell how much time had passed. See *Hourglass*; *Water clock*.

The first mechanical clock was probably invented in China in the late 1000's. However, this invention was never developed further, and later Chinese clocks were based on European models.

Historians believe the first mechanical clocks in Western civilization were developed by a number of inventors during the late 1200's. These clocks were weight driven, but they had no pendulum or hands. They had a bell that rang to indicate the hour. By the mid-1300's, the dial and hour hand had been added. The first spring-driven clocks were probably developed in Italy during the late 1400's.

Most early clocks ran unevenly and inaccurately. The pendulum and the balance spring, which were developed during the mid-1600's, greatly improved timekeeping accuracy. Minute and second hands became common. By the mid-1700's, inventors had developed most of the mechanisms found in modern mechanical clocks.

Electric clocks, introduced in the mid-1800's, were in many homes by the 1920's. Quartz-based clocks appeared during the 1930's, and scientists developed the first atomic clock in the 1940's. Digital clocks became popular in the 1970's, particularly as wrist watches. In the 1980's, the *chip*—a complex electronic circuit etched onto a tiny piece of silicon—was incorporated into clock mechanisms. Besides displaying the time, watches with electronic chips can store information, and serve as electronic calculators and miniature game boards.

Related articles in *World Book* include:

Atomic clock	Hour	Time
Banneker, Benjamin	Minute	Watch
Chronometer	Pendulum	

Cloister, in architecture, refers to a covered walk that encloses the courtyard of a monastery, convent, church, or college. Columns along one or more sides support

the roof. The term *cloister* can also refer to the courtyard itself or to any place of religious seclusion.

Both architecturally and symbolically the cloister unifies the monastery. An *oratory* (small chapel) or church usually opens off one side of the cloister. Common rooms and private rooms open off the other three sides. Many cloisters contain a garden and a fountain or well, and are used for work and recreation as well as for walkways. Cloisters are also sometimes used as graveyards for monks and notable associates of the monastery. See *Monasticism* (picture).

Beginning in the late 700's, the cloister became an important part of a monastery. Gradually, cloisters were added to other religious institutions and to colleges. Impressive cloisters can be seen at Westminster Abbey, Oxford University, and Eton College in England.

Clone is a group of organisms that are genetically identical. Most clones result from *asexual reproduction*, a process in which a new organism develops from only one parent (see *Reproduction*). Except for rare spontaneous mutations, asexually reproduced organisms have the same genetic composition as their parent. Thus, all the offspring of a single parent form a clone.

Single-celled organisms, such as bacteria, protozoa, and yeast, usually reproduce asexually. Clones of these organisms are useful in research. For example, various drugs and other compounds can be tested on bacterial clones. All the test bacteria have the same genetic makeup. Therefore, any differences in effectiveness among the different compounds result from the compounds themselves and not from the bacteria.

Algae, fungi, and such simple plants as club mosses can reproduce asexually as well as sexually and can be cloned. Higher plants usually reproduce sexually and form seeds. However, many—if not all—higher plants can also reproduce asexually through a process called *vegetative propagation*, and so they can form clones (see *Plant* [Asexual reproduction]). Plant clones are useful for measuring the effects of various environmental factors or chemical compounds on genetically identical plants. Breeders use cloning to collect plants with certain desired traits. Farmers and gardeners raise apples, potatoes, and roses by means of clones.

Hydras, flatworms, and some other animals can be cloned through asexual reproduction or *regeneration* (see *Regeneration*). But most higher animals cannot form clones naturally except when identical twins or other genetically identical multiple births occur.

See also *Genetic engineering*.

Clontarf, Battle of. See *Ireland, History of*.

Closed shop is a workshop or an industry in which only members of a trade union may be employed. In some closed shops, the union supplies all of the employees. When employees must be replaced, or new ones are needed, the employer obtains them through a union. Closed shops differ from *union shops*. In a union shop, an employer may hire nonunion employees, but the new workers must join the union within a short period of time after they have been hired. This is sometimes termed a *post-entry closed shop*. See also *Open shop*; *Trade unions*.

Clot. See *Blood* (Controlling bleeding; picture); *Anticoagulant*; *Coagulant*; *Fibrin*.

Cloth. See *Textile*; *Cotton* (Making cotton into cloth).



Masai people in Kenya



Shoppers in the United States



Eskimo in Alaska



Bullfighters in Spain



Women in Morocco

Clothing is one of people's most important needs. Most people wear some kind of garments, accessories, or ornaments. People in different parts of the world wear many different types of clothes. This variety occurs because individuals have different purposes for wearing clothes, use different materials and methods for making clothes, and follow different clothing customs.

Clothing

Clothing includes all the different garments, accessories, and ornaments worn by people throughout the world. An Eskimo may wear boots, warm trousers, and a heavy coat. An African in a village may wear only a piece of cloth tied around the waist. A nurse may wear a uniform and a special cap. A London banker may wear a business suit and a bowler hat. Each of these persons dresses differently, but they all feel a need to wear some kind of clothing. Like food and shelter, clothing is one of people's most important needs.

Throughout history, many people have worn clothing more for decoration than for covering the body. Even in cold climates, some people seem more interested in decorating their bodies than in protecting them. In the 1830s, for example, the famous British biologist Charles Darwin travelled to the islands of Tierra del Fuego, off the southern tip of South America. There he saw people who wore only a little paint and a small cloak made of animal skin, in spite of the cold rain and the sleet. Dar-

win gave the people scarlet cloth, which they took and wrapped around their necks. Even in the cold weather, these people wore clothing more for decoration than for protection.

No one knows exactly why or when people first wore clothes. But they probably began to wear clothing more than 100,000 years ago—and probably for much the same reasons we wear clothes today. Early people may have worn clothing to protect themselves, to improve their appearance, and to tell other people something about themselves. For example, a prehistoric hunter may have worn the skin of a bear or a reindeer in order to keep warm or as a sign of personal skill, bravery, and strength in hunting.

By the end of the Old Stone Age—about 25,000 years ago—people had invented the needle, which enabled them to sew skins together into clothing. They had also learned to make yarn from the threadlike parts of some plants or from the fur or hair of some animals. In addi-



Women in India



Schoolchildren in Japan



Ballet dancers in Russia



Football players in the United States



Colorado Indian in Ecuador

tion, they had learned to weave yarn into cloth. By this time, people had begun to grow plants that gave them a steady supply of materials for making yarn. They had also started to herd sheep and other animals that gave them wool.

These few advances took thousands of years. Most changes in the ways of making clothing and in the materials used for clothing have come only during the last few hundred years.

Until about 200 years ago, people had no machines for making clothes. Most families made their own clothing. Sometimes businesses paid groups of workers to make clothes, which the businesses then sold. But most of the people who made clothes worked at home. There were no clothing factories.

During the late 1700's and 1800's, the invention of several machines brought the clothing industry out of the home and into the factory. Machines that could spin thread, weave cloth, and sew clothes led to the growth of the clothing industry. Today, people in most parts of the world can buy ready-to-wear garments made in large clothing factories.

The clothing industry is a giant business in many countries. It is one of the largest industries in the world. Clothes and clothing materials are important items of trade between nations. Shoppers in many lands buy Italian knitwear and shoes, Australian wool, and Japanese silk. Stores throughout the world sell clothes designed in London, Paris, and Milan. As a result, many people in different countries round the world—especially people who live in cities—wear similar clothes. But there are still differences in dress among most regions of the world.

People in various regions dress differently for many reasons. They may need protection from different kinds of weather. They may have different materials and methods for making clothes, or they may have different habits of dress.

This article discusses why people wear clothes, describes clothing around the world, and traces the history of clothing. Then it describes the clothing industry. For further descriptions of the clothing worn by various peoples, see the many articles on different countries in *World Book*.

Most people, no matter where they live, wear some kind of clothing. Any person may wear certain clothing for a variety of individual reasons. But in general, people wear clothes for three main reasons: (1) protection, (2) communication, and (3) decoration. Most clothing serves all three purposes.

Protection. Clothing helps protect people's physical and emotional health.

Physical protection. People have probably worn clothing for physical protection since they first put on animal skins, leaves, or other clothing materials. In many areas of the world, people need clothing for protection from the weather. Clothing also protects people who work on dangerous jobs, take part in rough sports, or engage in other hazardous activities.

In cold climates, people wear warm garments made of wool, fur, or closely woven fabrics. They also wear warm shoes or boots.

In warm climates, people wear clothes made of such lightweight materials as cotton or linen, which have a fairly open weave. These materials absorb perspiration and allow air to flow around the body. People in these climates sometimes wear white or light-coloured clothes because such colours reflect the sun's rays. They may also wear sandals, which are more comfortable than shoes or heavy boots in warm weather. Large hats made of straw serve as sunshades.

In many places, people must wear clothes for protection against several kinds of weather. For example, peo-

ple of the Arabian deserts wear loose, flowing garments that shield their bodies from the blazing sun during the day. The same garments protect them against the cold night air. Even in less severe climates, people may require protective clothing during the hot and cold seasons.

Certain activities require special protective clothing. A soldier in combat wears a steel or plastic helmet and a nylon vest lined with plastic sheeting or fibreglass. Welders wear protective shields over their faces. Astronauts wear special suits and helmets for protection against changes of air pressure and temperature. Factory workers wear heavy shoes to protect their feet. Some sports players wear padded equipment to guard against injury.

In some societies, people may wear clothing for protection against unusual types of physical harm. For example, people in France wore plain clothes during the French Revolution in the late 1700's. Revolutionaries might have thought that people wearing fancy clothes belonged to the upper class, and they would probably have killed them. In some countries, people believe that evil spirits can cause bodily harm. These people may wear special clothes that they think have magic power to protect them from such spirits.

Emotional protection. Clothing protects people's emotional health by helping satisfy some of their needs. For example, most people need to feel they are accepted as members of society or of some special group. Many people also want to feel they are independent individuals—different in at least some small way from everyone else.

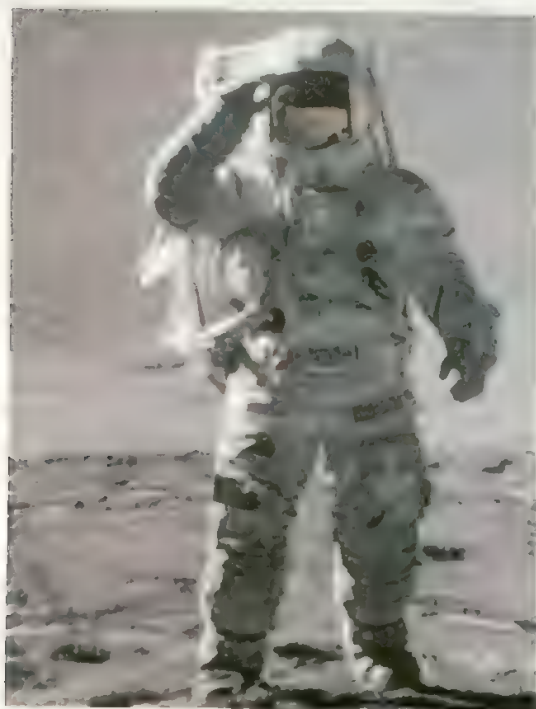
People who want to belong to a certain group usually dress in a style similar to that of people in the group. Through their choice of clothes, they tell members of the group that they share their attitudes, beliefs, and way of life. People who want to show their independence may wear different styles of clothing from that worn by others. By wearing such clothes, they seem to say, "Look at me. I am someone special."

Communication. People communicate by means of the clothes they wear. Their clothes may tell others who they are, what they are like, how they feel, and what they would like to be.

Who people are. People can identify some famous individuals, such as a well-known politician or actor, without looking at their clothes. However, few individuals are so well known. In most cases, a glance at a person's clothes helps people identify the person.

Clothing may reveal such facts as a person's occupation, approximate age, and sex. Bus drivers, postal workers, nurses, police officers, and priests wear special clothing to help other people know what they do. People of different ages usually dress differently, and men and boys dress differently from women and girls. Some types of dress or uniforms show that a person belongs to a certain group. For example, Scouts and Girl Guides wear special uniforms.

What people are like. Clothes tell something about people's beliefs and feelings, their personality, and their general approach to life. Confident people often show more independence in choosing their style of dress



Astronauts wear protective clothing. The space suit worn by astronauts on the moon protected them from heat and cold. It also provided an artificial atmosphere in which they could live.



A uniform is the distinctive clothing that identifies a person as a member of a certain group or organization. For example, these men are wearing a uniform that shows they belong to the *Garda Síochána*, the police force of the Republic of Ireland.

than do people who are shy or unsure of themselves. The confident individual is likely to try new clothing styles. A shy person may seek security by following current styles. Others may be unconcerned about their dress and care little whether they dress in what others consider attractive clothing.

Some persons wear plain clothes because of strong beliefs about personal behaviour. They believe it is wrong to care about wearing clothes as decoration and that, instead, people should be concerned with other matters. Members of the Amish religious group in the U.S.A. and Canada have this kind of belief. Amish men wear plain, dark clothes, and Amish women wear long, plain dresses.

How people feel. Clothing often helps communicate the mood of a person. People who are sad or upset may show little concern for their appearance. Clothing with bright colours and bold designs may indicate happiness. Such clothing may even brighten the mood of others who see a person wearing it.

In many societies, clothing of certain colours has special meaning. For example, people in mourning may wear black clothes. But colours may have different meanings in various societies. A colour worn for weddings in one country may be worn for funerals in another land. Brides in many countries wear white gowns.

But people in India wear white clothes to mourn the dead.

What people want to be. People often wear clothes that they think make them appear a certain way. People may dress to hide their feelings or their age, or they may dress like people in some occupation. A person who feels sad may wear bright clothes to hide this mood from others. Many children enjoy wearing the clothes of their mother or father to "play grown-up." A person entering show business may imitate the dress of some entertainer whose success is established. When applying for jobs, many people wear clothes that they think make them look older or younger than their real age. They may also dress as they think people holding a certain job should look.

Decoration. Most people want to wear clothing that makes them feel attractive—even if its chief purpose is protection or communication. Such protective clothes as raincoats, snow boots, and sweaters come in bright colours and bold patterns. Some women wear expensive furs more for beauty than for warmth. Even military uniforms are designed to improve the appearance of servicemen and servicewomen.

Many people accept frequent changes in clothing styles because they want to appear attractive by wearing the latest fashions. A woman may stop wearing an old coat that is still in excellent condition. She does so because she feels it no longer makes her so attractive as does a new style of coat.



A ceremonial costume is probably worn more as decoration than as covering by this man in New Guinea. Decoration is one of the chief reasons most people wear clothing.

For thousands of years, people in different parts of the world have worn different types of clothes. Today, the Western style of clothing—common in Europe, Canada and the United States—has spread throughout the world. But the clothing worn by different peoples still varies widely, especially among people who do not live in cities.

Why clothing varies. There are four main reasons for worldwide variety in clothing: (1) differences in the purposes for wearing clothes, (2) differences in the materials available for making clothes, (3) differences in ways of making clothes, and (4) differences in clothing customs. These differences result in clothing variety

from continent to continent, from country to country, and even from person to person.

Purpose. As we have seen, people wear clothes for three basic purposes—protection, communication, and decoration. But people in various regions of the world often need different kinds of protection, especially if they live in different climates. People may also wear clothes that have a special meaning not understood by people of other countries. For example, many Muslim women wear veils in public because their religion requires them to hide their faces from strangers. In addition, people have different ideas about what makes clothing attractive.

Different purposes for wearing clothes cause much of the worldwide variety in clothing styles. People wear clothes for various kinds of protection. They also wear clothes to communicate with other people and to decorate themselves. The pictures in the first row below show examples of clothing worn for protection in different climates. The pictures in the second row show examples of garments worn in various countries for communication and for decoration.

Clothing in hot climates



Boy in American Samoa



Old man in Mexico



Russian family in Moscow



Lapp family in Finland

Clothing for communication



Chef in France



Nurses in the United States

Clothing for decoration



Geishas in Japan

Available materials. People in different countries may have different materials available for making clothes. For example, the people of France can wear clothes made from a much greater variety of materials than can the people of China. French stores sell garments made not only of such natural materials as cotton, fur, leather, silk, and wool, but also of such artificially made fibres as nylon and rayon. Most people in China must choose clothing made of cotton.

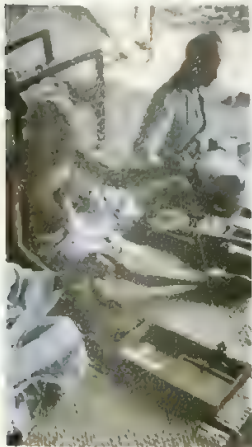
Ways of making clothes vary from country to country. Highly industrialized nations, such as Canada, Japan, the United States, and western European countries, use many kinds of machines and many processes to make clothes. For example, textile manufacturers in those countries can rapidly produce yards of cotton cloth woven many different ways. They can also dye and print

the cloth and rapidly sew it into many different kinds of clothes.

People living in a village in India may have only hand-powered equipment for weaving cloth. They may create a variety of designs—maybe more than a machine can—but they need much more time than a machine to make the cloth. They would also have to sew clothes by hand.

Clothing customs affect styles. These customs develop in a country as generation after generation of children learns what clothes to wear. For example, a Mexican farmer and a Chinese farmer may wear clothes made from similar materials and by the same basic methods. They also may need their clothes for the same purpose. But the custom in Mexico is to wear straw hats with brims that tilt up. In China, custom calls for straw hats with brims that slant down.

Different materials and methods for making clothes produce differences in clothing styles. Cotton clothes, for example, look quite different from clothes made of plastics. The pictures below show some of the materials and methods used for making clothes.



Spinning cotton by hand



Power loom in operation



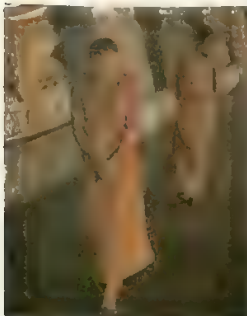
Leather clothing



Wool clothing in Australia

Differences in clothing customs result in differences in clothing styles. Such special clothing as uniforms and ceremonial garments clearly illustrate the influence of clothing customs. The pictures below show clothing worn by religious groups and police forces.

Religious clothing



Buddhist monks



Catholic nuns

Police uniforms



Royal Canadian Mountie



Policeman in India

Traditional costumes

Traditional costumes of many lands are shown on the following four pages. Such styles of clothing developed over hundreds of years. Many of the costumes shown are no longer worn, or are worn only as part of celebrations during festivals and holidays. This is especially true of the European costumes shown. Many of the costumes on the first two pages are still worn as everyday dress, particularly in rural areas. Traditional costumes are often called *national costumes*. But most such costumes do not represent all the people of a nation.

Africa and the Middle East



Morocco Senegal Ghana



Kenya Somalia Syria Israel South Africa



Egypt Zaire Ethiopia Nigeria Saudi Arabia

Asia and the Pacific Islands



China

Mongolia

Burma



India

Indonesia

Tahiti

Philippines

Thailand



Korea

Malaysia

Vietnam

Afghanistan

Japan

Europe



Switzerland

Germany

Austria

Norway

Sweden



The Netherlands

Scotland

Wales

France

Greece



Spain

Czech Republic

Russia

Hungary

North and South America



United States Eskimos



Mexico



United States Cowboy



United States Indians



Guatemala



Brazil



Chile



Ecuador



Bolivia



Argentina



Peru

For thousands of years, people have worn some kind of clothing. They probably made their first clothes from the fur of animals they killed. Gradually, they learned to use other materials. They also invented tools and machines to weave cloth and sew clothing.

This section of the article covers chiefly the history of clothing in the Middle East, Europe, and North America. The people of these regions have made the greatest contribution to the development of the Western style of dress. Information about non-Western clothing appears in other *World Book* articles. For example, see the *Indian, American*, article to learn about the clothing of North and South American Indians. See the *Africa* and *Asia* articles for information about clothing worn on those continents. Also see such country articles as *Argentina* and *Japan* to learn about the clothing worn by the peoples of those countries.

Ancient times began more than 5,000 years ago and lasted until about the A.D. 400's. Most of our information about clothing worn in ancient times comes from vases, statues, and *frescoes* (wall paintings). A large amount of jewellery has survived from the period. However, few woven fabrics or leather items have lasted through the years. Some garments from ancient times have been preserved under special conditions, such as the dry climate of Egypt.

The colours of most ancient paintings and statues have worn away through the centuries. For that reason, clothing shown on such items appears white or light-coloured. Some ancient peoples—such as the Egyptians—actually wore white clothes. But many other peoples probably wore colourful garments. For example, frescoes uncovered during the 1700's at the site of the ancient Roman city of Pompeii show people wearing brightly coloured clothing.

The Egyptians used linen in making most of their clothes. Many slaves and children did not wear clothes, but high-ranking families wore them to indicate their status in society. The Egyptians wore garments made of rectangular pieces of fabric.

During the early years of the ancient Egyptian civilization, men wore a wide girdle, a nappylike *loincloth*, or a short, wraparound skirt. Through the years, men began wearing longer skirts, and they often wore one skirt over another. Egyptian women at first wore sheathlike dresses. These tight-fitting garments had either one or two straps over the shoulders. Most of the dresses hung to the feet and left the breasts bare. The women often wore jewellery.

Later, both men and women often wore long, robe-like garments instead of skirts and dresses. They made these robes by folding rectangular pieces of cloth in half



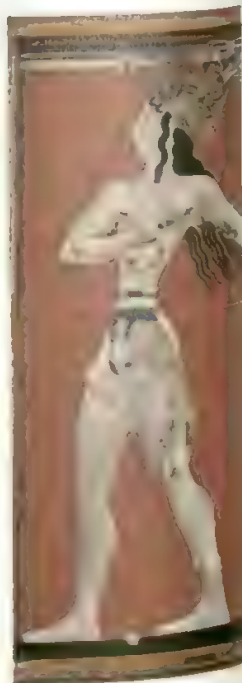
Wooden statue from Egypt (2300's B.C.). The Brooklyn Museum, Brooklyn, New York



Stone statue from Sumer (about 2300 B.C.)



Sculpture from Iraq (800's B.C.). The Brooklyn Museum, Brooklyn, New York



Wall painting from Knossos, Crete (about 1500 B.C.)

Skirts were a common type of clothing worn by many Egyptian men. Men often wore one skirt over another. The Egyptians made most of their clothes from linen.

The kaunakes was a type of skirt worn by the Sumerians. Historians believe that the kaunakes was made of sheepskin or of cloth covered with several rows of wool fringe.

The Assyrians usually put fringes on their clothing. King Ashurnasirpal II, above, wore the style of beard and long, curled hair common among Assyrian men.

The Cretans wore clothing different from that of any other ancient people. The men wore short skirts held up by a belt. Some of these belts may have been metal.

lengthwise and cutting a hole on the fold for the head. People wore the robes draped in various ways. Sometimes they let the robes hang straight and full. Other times they tied the robes at the waist with a wide sash.

Egyptian men and women both wore wigs made of human hair, palm-leaf fibres, or wool. Many men shaved their heads, and so did some women. Men and women occasionally wore sandals, but most Egyptians went barefoot. See *Egypt, Ancient* (Food, clothing, and shelter; pictures).

The Sumerians, Babylonians, and Assyrians herded sheep and dressed in the wool their flocks provided. They lived in Mesopotamia, an area that extended through parts of what are now Iraq, Syria, and Turkey. The Sumerians lived in the southern part of this region. The Babylonians lived in the centre, and the Assyrians in the north.

The Sumerians wore either a smooth-fitting skirt with a fringe at the bottom or a skirt called a *kaunakes*. Some historians believe the kaunakes was made of cloth covered with rows of wool fringe. Others think it was made of shaggy sheepskin. Sumerian women wore a capelike garment in addition to the kaunakes. The Assyrians and Babylonians wore chiefly a large shawl or scarf wrapped around the waist and hips. They arranged this garment with one end draped over the left shoulder. The Assyrians and some Babylonians wore a short-sleeved tunic under the shawl.

The people of Mesopotamia usually had a fringe on the edges of their clothing. During the early years of this period, they wore various types of headdresses and generally went barefoot. Later in the period, these people wore sandals, shoes, and boots. Assyrian men had long, heavy, curled hair and black beards.

The Persians were among the first people to cut and fit garments, rather than simply drape themselves in pieces of fabric. Ancient Persia covered much of what is now Iran.

The Persians were hunters and horsemen. Historians believe they began to wear fitted animal skins because the fitted clothing was better suited to hunting and riding than were loose, flowing garments. Later, they made garments of woven cloth.

Persian men wore trousers that were tightly fitted at the ankles. Shoes or boots were worn with the trousers. The men also wore tunics and coats with sleeves. Persian women wore garments similar to those of the men, but they also wore long veils. Persian garments set a pattern for the fitted type of clothing that later developed in western Europe.

The Hebrews left little information about their clothing. The Old Testament provides some description of early Hebrew garments, and some paintings and carvings from the years of Assyrian and Egyptian rule show Hebrew people. These sources indicate that the Hebrews dressed much like their Middle Eastern neighbours, who wore wraparound shawls and tunics. According to the Bible, the Hebrews sewed tassels on their clothing. The men wore locks of hair called *sidelocks* on the side of the head. For religious reasons, the Hebrews avoided wearing clothing made of a mixture of linen and wool.

The Cretans lived on Crete, an island about 130 kilometres south of Greece. They wore clothes unlike those of any other ancient people. Cretan women wore dresses that had the tight-waisted, corseted look of Western women's dress of the mid-1800's. Skirts on the dresses were long and bell-shaped with layers of wide ruffles. The women's blouses had sleeves but left the breasts bare. The women used hair ornaments, necklaces, and other jewellery.

Cretan men wore short skirts that dipped at the front and back. The skirts were held at the waist by tight belts, some of which may have been metal. Men wore boots or sandals or went barefoot. Both men and women wore various types of headdresses.

The Greeks wore soft, flowing garments made of rectangular pieces of cloth. Men and women wore the same types of clothes. Common garments included the *chiton*, a straight, hanging garment fastened at the shoulders and tied at the waist, and the *himation*, a kind of large cloak. The *chlamys* was a shorter cloak for a man that left his fighting arm bare.

Greek jewellery included gold earrings, hair decorations, and brooches called *fibulae* for fastening garments at the shoulder. The people went barefoot at home and wore boots or sandals for hunting and traveling. Men wore a broad-brimmed hat called the *petasos* and a narrow-brimmed or brimless hat called the *pilos*. Greek women decorated their heads with a great variety of bands, caps, and scarves. See *Greece, Ancient* (pictures).

The Romans wore clothing based chiefly on that of the Greeks. The Greek *chiton* and *himation* became the



Archaeological Museum, Knossos, Crete

Cretan women wore elaborate dresses similar to that of the Cretan snake goddess shown above. The women also wore hair ornaments, necklaces, and other kinds of jewellery.



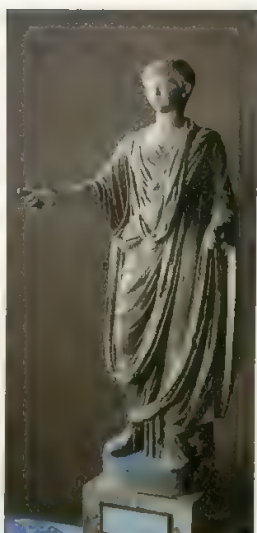
Sculpture from the Acropolis, Athens (about 460 B.C.)

The chiton, above, was a straight, hanging garment commonly worn by the Greeks. They often used brooches called *fibulae* to fasten the chiton at the shoulder.



Statue, *Sosandra of Calomis*
(about 460 B.C.)

Greek men and women both wore soft, flowing garments. The Romans had similar styles of clothing because they based their garments chiefly on those of the Greeks.



Statue (A.D. 100's) of the
Louvre, Paris

Roman boys wore a good luck charm called a *bulla* around the neck. They wore it until manhood. The boy shown above has on a type of cloak called a *toga*.

Roman *tunic* and *pallium* for men and the *stola* and *palla* for women. The tunic varied in length but was short for soldiers. The stola hung to the floor. It was worn over a long tunic called the *tunica talaris*, a short shirtlike garment called the *camisia*, and a tight, corsetlike band of cloth called the *strophium*. The pallium and palla were outdoor garments that the Romans could use as blankets if necessary.

Roman citizens wore a carefully draped cloak called a *toga*. The toga hung over the left shoulder and was wrapped around under the right arm. Only people who were citizens of Rome could wear it. Slaves and exiled citizens were forbidden to wear the toga. Freed slaves were required to have special permission to wear it. See *Toga*.

Later in the Roman period, both men and women wore a type of wide-sleeved tunic called the *dalmatica*. Boys and girls wore a locket called the *bulla* as a good luck charm. Boys wore the *bulla* until manhood. Girls wore it until they married. Men wore sandals, shoes, and boots. Women usually wore sandals, though they also wore shoes.

The Romans developed an enormous trade in textiles. They imported woolsens from Britain and Gaul (Gaul was the name of the land which now includes France, Belgium, and part of Germany), linen from Egypt, cottons from India, and silks from China and Persia. See *Rome, Ancient* (pictures).

The Middle Ages began with the fall of the West Roman Empire in the late 400's and lasted until about the 1400's. During the Middle Ages, western Europe developed independently of what remained of the old Roman

Empire, which was called the *Byzantine*, or *East Roman*, Empire.

The Byzantine Empire. The ruling classes of the empire wore highly decorated cloaks and tunics. These wealthy people used silk fabrics woven with threads of gold, and they decorated their clothes with pearls and precious stones. Poorer people wore plain tunics and blouses.

During early Byzantine times, the emperor and the men of his court wore a type of cloak called a *paludamentum* over their tunics. The empress also wore a paludamentum, and with it she wore a wide jewelled collar called a *maniakis*. Women of the court wore long stolas and pallas. In later Byzantine times, the emperor and empress wore a long, narrow scarf called a *lorum* instead of a paludamentum. Noblemen began to wear long, tight stockings called *hosa*.

Western Europe. The Celtic peoples of Britain and Gaul had adopted some ideas from Roman clothing during the time of the Roman Empire. During the Middle Ages, the styles of the Byzantine Empire gradually blended with those of western Europe. Through the years, Byzantine clothing increasingly influenced the style of dress in western Europe. Members of the ruling classes especially began to wear clothes that were fancier than the usual rough garments made of cloth, fur, and leather.

During the early Middle Ages, people made their



Detail of a mosaic (524-547) church of San Vitale
Ravenna, Italy

Clothing of early Byzantine times included garments like those worn by the emperor and the men of his court. The picture above shows Emperor Justinian and some of his attendants

clothes at home as they had done for hundreds of years. Families raised sheep and grew flax. They spun thread and wove it into fabric for their clothes. As towns grew, specialized shops gradually appeared, run by weavers, tailors, cobblers, and other craftworkers who made clothes. During the 1100s, these craftworkers began to organize simple labour unions called *guilds* (see *Guild*). The quality of cloth improved as the craftworkers developed greater skills. They began to cut, fit, and decorate clothes in more elaborate ways.

Men and women of the early Middle Ages wore simple tunics and circular or rectangular cloaks. Later, fitted clothes began to replace the loose, flowing cloaks and tunics. The woman's tunic developed into a long dress that was laced to closely fit the upper part of her body. Men wore loose breeches under their tunics. They also wore various kinds of tight leg coverings. For example, they might wrap their legs in long pieces of cloth or wear long stockings of bright colours.

During the 1100s and 1200s, women wore metal hairnets, veils, and draped throat covers called *wimples*. Men wore hoods that had long tails called *liripipes*. Both men and women wore a type of outer tunic—adopted from the crusaders' garments—called a *surcoat*. Some surcoats were sleeveless and cut with low armholes. The woman's surcoat was long and worn over a

long-sleeved gown. Men wore sleeveless surcoats of various lengths, from knee-length to ankle-length.

During the 1300s, clothes of the upper classes became increasingly elaborate, and accessories became popular. Dozens of buttons were used to trim men's outer garments. Many clothes had decorative edging called *dagging*. Men wore a close-fitting, low-waisted jacket called a *cote-hardie* with an expensive jewelled belt. A long, tight-fitting gown worn by women had the same name. In the late 1300s, both men and women wore fancy garments called *houppelandes*. At first, the man's *houppelande* was a long outer garment that hung to the floor. It was gradually shortened and became a jacket. The woman's *houppelande* was long and high-waisted with long, flaring sleeves.

In the later Middle Ages, the wealthy wore silks and other fine fabrics woven in Italy and Spain or brought to Europe from the East by traders. Lords and ladies of the courts trimmed their clothes with expensive ermine, marten, and sable fur. But most people wore linen and wool clothes. Their style of dress was much plainer than that of the ruling classes. The lesser nobility and the middle classes lined and trimmed their clothes with fox, otter, and rabbit fur. The common people wore garments made of the skins of goats, sheep, or wolves. See *Middle Ages* (pictures).



Detail of an illuminated Old Testament manuscript, The Pierpont Morgan Library, New York City

The surcoat was a tunic worn in Europe in the 1200s. These knights wear surcoats over chain-metal armour.



Detail of an illuminated manuscript, *Le Roman de la Rose*, Bibliothèque Nationale, Paris

The wimple was a throat cover worn by western European women during the 1200s. The women wore it with various hoodlike head coverings.



Detail of *Elderly Couple* by Jan Gossaert (about 1520), The National Gallery, London

Fur trim was worn on clothing during the 1400s and 1500s. Fox and rabbit fur were often used.



Detail of a painted chest, Accademia di Firenze, Florence, Italy

Italian clothing became more elaborate during the Renaissance than ever before. In this wedding scene, the two men at the far right wear a kind of draped turban called a *chaperon*.

The Renaissance began in Italy about 1300 and spread throughout Europe during the 1400's and 1500's. Towns thrived during the Renaissance, and the number of merchants and craftworkers grew rapidly. The Byzantine Empire fell, and western Europe took the lead in clothing design. European dress of the 1400's shows the influence of ideas and attitudes that developed during the Renaissance.

Clothing was more decorative and complicated than ever before. Women wore many kinds of elaborate headdresses, including the high, cone-shaped *hennin*. The *hennin*—worn in many European countries during the late 1400's—rose to about 1 metre high and was draped with a veil. Jewellery and bright-coloured fabrics with large, flowered designs were popular.

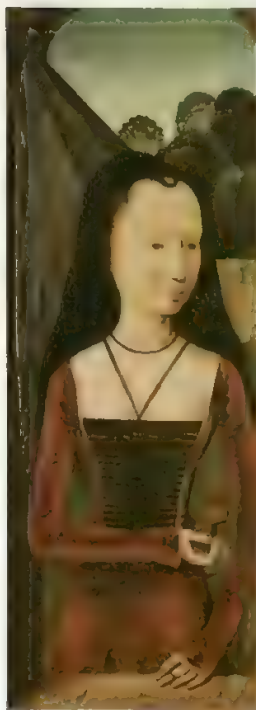
Men wore longer stockings as jackets became shorter. The stockings became close-fitting trousers that resembled tights. Men wore many kinds of hats, including a draped turban called the *chaperon*. They also wore pointed-toe shoes called *poulaines*. On some shoes, the points measured 15 centimetres or more.

Men of the early 1500's wore many layers of outer garments, and their clothing was heavily padded. They put on linen shirts under tight-fitting upper garments called *doublets*. Over the doublet, they wore a jacket called a *jerkin*, which had a skirt that hung to between

the waist and the knee. A knee-length gown with large sleeves came over the jerkin. Men also wore short, puffed breeches called *upper stocks* that were sewn to tight stockings called *netherstocks*.

Women's clothing was cut and sewn to fit tightly above the waist. During the first half of the 1500's, women wore dresses with low, square necklines and with skirts propped out stiffly over petticoats. Many skirts were split in front to show elaborate underskirts. Both men's and women's garments were often slashed so that the fabric of garments worn underneath could be pulled through in small puffs.

The stiff and formal fashions of the Spanish court influenced styles throughout Europe during the late 1500's. Men wore stockings and either padded breeches called *trunkhose* or slimmer knee breeches. Padding in the doublet developed into the *peasecod belly* fashion, which had a pointed bulge over the abdomen. The wide skirts of women's dresses were supported by a device called a *farthingale*. One type of farthingale was an underskirt with a rigid frame made of whalebone, wire, or wood. The frame made the skirt stand out stiffly away from the body. Another kind of farthingale was a long, thick pillow that women tied around the waist under a dress. Both men and women wore decorated starched collars called *ruffs*. See Renaissance (pictures).



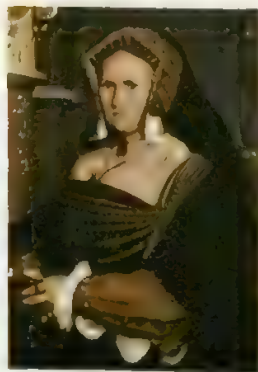
Lady with a Pearl by Hans Memling. The Metropolitan Museum of Art, New York City.

The *hennin* was a style of high, cone-shaped headdress worn by European women during the Renaissance.



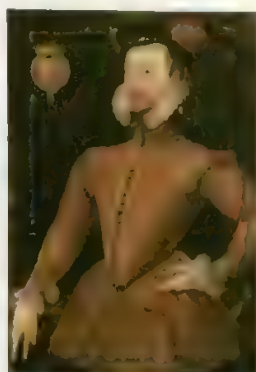
Detail from a manuscript of the 1400's, Bibliothèque Nationale, Paris.

Renaissance clothing included men's hats with the brim pointed in front and turned up at the back. King Louis IX of France wore such a hat when he started on a crusade, as shown above.



Detail of *Portrait of Lady Guilford* by Hans Holbein the Younger. The City Museum, St. Louis, U.S.A.

Puffs of fabric were often pulled through slashes in clothing in the Renaissance.



Earl of Leicester by an unknown artist. National Portrait Gallery, London.

Stylish men of the 1500's wore a *peasecod belly*, which bulged over the abdomen.



Portrait of Marboregh by Anton van Dyck. The Louvre, Paris.

The *ruff* was a large starched collar worn by men and women in the Renaissance.

The 1600's. Elaborate, decorated clothing remained popular throughout most of Europe during the 1600's. Spain declined in importance, and France took the lead in setting clothing styles.

Men began to replace their doublets with waistcoats worn under knee-length coats. In the mid-1600's, loose, knee-length trousers took the place of tight, padded breeches. But knee breeches came back into style by the end of the century.

Except in Spain, women began to wear many petticoats instead of farthingales under their gowns. Women also started wearing three-quarter sleeves. This startling change bared female arms for the first time since the fall of the Roman Empire more than 1,000 years earlier. With the shorter sleeves, women wore muffs and longer gloves. By the late 1600's, they were wearing *bustle* gowns. A bustle was a cushion that made a skirt stick out at the back. Women also wore a type of high head-dress called a *fontange*.

Men often wore high boots, and they carried a sword on a long sash that hung over the shoulder. They also wore fancy plumed hats over their long hair. Both men and women began to wear high-heeled shoes, many of which were trimmed with bows and buckles. Flat collars

made of lace and linen gradually replaced the stiff ruff. A scarflike neckcloth, in turn, succeeded the flat collar in the late 1600's. Men began wearing huge, curled wigs called *periwigs* by about 1660.

The Puritans in England and the Puritan colonists who settled in America preferred plainer versions of the clothing of the day. The women wore plain, dark-coloured dresses and simple white caps. The men cut their hair short and wore high, stiff hats. They dressed in dark-coloured breeches, doublets, and jerkins. Both men and women wore white collars.

The 1700's brought many changes in the manufacture of cloth. About 1764, James Hargreaves, an English weaver, invented the *spinning jenny*, a machine that spun a number of threads at the same time. Then, between 1774 and 1779, an English weaver named Samuel Crompton developed the *spinning mule*. This machine produced as much thread as could 200 persons spinning by hand. In the mid-1780's, Edmund Cartwright, an English clergyman, developed a steam-powered loom. With such machines as these, English weavers produced large quantities of cloth at prices lower than those charged by guild craftworkers, who wove by hand. Large factories took over the production of cloth, and many people stopped making cloth at home. See *Industrial Revolution*.

Clothing styles changed rapidly. But only the nobility and the wealthy could afford the new fashions. Most people still wore comfortable, long-lasting woollen clothing. Many continued to make their own fabrics and clothes.

French fashions set the clothing standards in Europe during most of the century. But late in the 1700's, the French Revolution interrupted France's fashion leadership, and England took the lead. After the revolution, France regained leadership in the design of women's clothes, but English tailoring continued to influence men's fashions. Clothing styles in England and France



James Stuart, Duke of Richmond and Lennox by Anton Van Dyck, The Metropolitan Museum of Art, New York City



Marie Thérèse of Spain, Queen of France, and the Grand Dauphin by Pierre Mignard; The Prado, Madrid

Clothing of the 1600's included high-heeled shoes for men and women. Many shoes were trimmed with bows. Lace and linen collars became popular in the 1620's.

Three-quarter sleeves were worn by women during the 1600's, as were long gloves or muffs. To make their dresses curve out from the waist, women wore many petticoats.



Detail of *Salon of Madame Geoffrin* by an unknown French artist, National Museum of Versailles and of the Tranons Versailles, France



Detail of *Portrait of the Artist with his Wife and Daughter* by Nicolas de Largillière, The Louvre, Paris

Waistcoats worn under knee-length coats replaced the doublet as the fashion for men during the 1600's. Men wore knee breeches during much of the century.

Periwigs were huge, curled wigs worn by men during the late 1600's and the 1700's. Men began to wear a scarflike neckcloth instead of the flat collar in the late 1600's.

influenced those in the United States. Many Parisian designers distributed dolls dressed in fashions to be copied in England, America, and other parts of the world.

Both men and women wore elaborate hairstyles. Men covered their heads with large powdered wigs of various shapes. By the 1770's, women wore their hair in high, carefully arranged styles called *pompadours*. They made their hair stiff with grease and powder and decorated it with feathers, jewels, and ribbons. They also added hairpieces to their own hair and wore wigs. Sometimes women did not comb out or re-dress their hair for several weeks because the styles were so complicated.

Women wore tight corsets and great round skirts held out by a hoop. During the 1780's, a bustle replaced the hoop. The style included very large fancy hats. Men wore variations of the coats, waistcoats, and breeches introduced during the late 1600's.

The outbreak of the French Revolution in 1789 brought great changes in clothing style in France and throughout the rest of Europe as well. Men started to wear much plainer clothes, with less colour and ornamentation. They adopted top hats and hats called *bicornes*. Bicornes had brims folded up to form two points. These hats replaced the *tricorne*. The tricorne, which had the brim folded to make three points, had been popular for most of the 1700's. Women began wearing clothing that imitated the styles of ancient Greece. This clothing included sandals and lightweight cotton dresses. Women cut their hair short and curled it, and they wore wide-brimmed bonnets. Dresses had low necklines and high waistlines with drawstrings. This dress style became known first as *Directoire* and then, in the early 1800's, as *Empire*.

The 1800's. Much production of clothing by hand ended during the 1800's, and the clothing industry became firmly established in Europe and the United States.

Two Americans—the inventor Elias Howe and a machinist named Isaac Singer—developed improved sewing machines in the mid-1800's. These machines and other inventions made the manufacture of cloth and clothing easier. Manufacturers began to make inexpensive, ready-to-wear clothes. Production methods used by manufacturers gradually improved. But many people still preferred to have their clothes made by a tailor or dressmaker if they could afford it. Others continued to wear homemade garments.

The Empire style lasted until the 1820's. Tight-waisted, full-skirted gowns became popular during the 1830's and 1840's, and women wore many petticoats under them. By the 1850's, women wore stiff wire or whalebone petticoats called *crinolines* to support their skirts. Earlier types of crinolines were underskirts made partly of horsehair.

By the 1870's, full-skirted dresses gave way to bustle gowns. In the 1880's, a European designer introduced the first suits for women. A type of blouse called a *shirt-waist*—worn with a separate skirt—became fashionable in the Gay Nineties. Women wore costumes that were designed in an "hourglass" style. This style required a woman to lace in her waist tightly to make it as small as possible.

In the 1800's, men's clothes continued to become plainer. By about 1815, fashionable men in Europe and the United States were wearing trousers instead of knee breeches, which had been the style for more than 200 years. For general wear in the early part of the century, men wore the long *tail coat*. Later, the knee-length, full-skirted *frock coat* replaced the tail coat. Then the plain *sack coat*, which is still worn today, replaced the frock coat. Men kept the tail coat for formal wear only. A coat called a *dinner jacket*, also worn for formal occasions, was introduced in the late 1800's. Men also wore caps, round bowler hats, high top hats, and straw hats.



Detail of *Gathering in a Park* by Louis Joseph Watteau. Cognac-Lévy Museum, Paris.

Large, fancy hats became stylish for women during the late 1700's. Women also wore tight corsets and round skirts.



Detail of *Portrait of Madame Guise* by Jacques-Louis David. The Louvre, Paris.

Women's clothing became simpler in the early 1790's. Fashionable women wore lightweight cotton dresses.



Illustration of a woman in a tight-waisted dress. The Louvre, Paris.

Tight-waisted dresses with full skirts were popular in the 1830's. Women wore many petticoats under their skirts.



Illustration of men in formal attire. The Louvre, Paris.

Fashionable men of the 1800's wore the frock coat left, the tail coat, centre and right, and top hats.

Knickerbockers, which resembled the old knee breeches, became popular for sports after 1870.

The 1900's. From 1890 to 1920, improved manufacturing methods brought rapid growth to companies that made ready-to-wear clothing. Both men and women began to wear clothing that was mostly *mass-produced* in factories (see *Mass production*). As a result of mass production, women's fashions could change more rapidly than ever before. But men's clothing styles changed little until the 1960's.

In the 1900's, women began to wear looser, lighter-weight clothing. The changing styles—especially in leisure and sports clothes—gradually uncovered different parts of women's bodies. Legs were bared in the 1920's, abdomens in the 1940's, and thighs in the 1960's. Today, women wear less clothing than in any other period since ancient times.

For a few years around 1910, women wore *hobble skirts*. These skirts were so tight at the bottom that a woman could hardly walk. Clothing became simpler and less formal during World War I (1914-1918). In the 1920's, women adopted the "boyish" look. Dresses were straight and unfitted, and they ended at, or a little above, the knee. In the 1930's, some women began wearing slacks (trousers). Skirts became longer during the 1930's and then shorter during the early 1940's. During World War II (1939-1945), women wore many tailored styles with padded shoulders. Slacks—worn by women working in war industries—also became popular.

Women's fashions changed greatly after World War II. Crinolines and long, full skirts returned. Nylon garments, including stockings and *lingerie* (underwear), became available in large quantities. During the 1950's, straight, tight-fitting *sheath dresses* and shorter hemlines gained popularity. *A-line dresses* and loose-fitting *shifts* came into style during the early 1960's. The very short *miniskirt* quickly spread to other countries after it

first appeared in England during the mid-1960's.

From 1900 to 1950, both single-breasted and double-breasted men's suits were popular. Shoulders were *natural* (unpadded) in about 1910 but gradually became more padded. During the 1950's, many men switched to single-breasted suits, which had narrow lapels and natural shoulders. They also began wearing coloured shirts with business suits.

Both men and women developed great fondness for sportswear and wash-and-wear fabrics during the 1950's and 1960's. Leisure and sports clothes for women included knee-length Bermuda shorts, tapered slacks, and ski and stretch pants. Men wore Bermuda shorts, slacks, and colourful sports shirts. Improvements in sewing machines and in dress patterns brought an increased interest in sewing.

In the 1960's, many young men started to wear colourful fashions, many of which included fancy jewellery. They also grew beards and moustaches. During the early 1970's, men of all ages joined in the change to colourful clothes. They began wearing checked or striped shirts in a variety of colours with business suits. They also wore wide ties in fancy prints, stripes, or bright swirling colours. Men of all ages began growing beards and moustaches. They also began wearing their hair longer than in the 1960's. Women's fashions included skirts of every length—from the miniskirt to the *maxiskirt*, which fell to the ankle. Many people seemed to have an "anything goes" feeling toward clothing styles.

During the 1980's, fashions "softened." In the early 1980's, men wore suits with padded shoulders but a loose fit. By the late 1980's, suits had natural shoulders and were less formal. Women's fashions included many options. Women wore trousers, skirts of every length, and casualwear that combined sweaters, jackets, skirts, and dresses. Tight-fitting exercise wear was popular, but so too was oversized, baggy clothing.



The hourglass style was worn by women during the 1890's. This style called for waists laced in tightly to make them as small as possible.



The boyish look was fashionable during the 1920's. Women wore straight, unfitted dresses that hung to the knee, and long necklaces.



Trouser suits became stylish for women during the 1940's. Fashionable women generally wore tailored styles with padded shoulders.



Tailored clothing with loose, casual styling became popular business wear for both men and women during the 1980's and early 1990's.

The clothing industry is one of the largest industries in the world. It includes the manufacture of women's, children's, and infants' clothes and men's and boys' wear. The industry also produces furs, including "fake furs"; embroidery; hats, jewellery, shoes, and other accessories; buttons, hooks and eyes, zips, and thread; underwear and nightwear; and sportswear.

The main clothing centres of the world are London, New York City, Paris, and Milan. The United States is the world's leading manufacturer of clothing. There are about 24,000 U.S. clothing manufacturers, and they employ about 1,400,000 people. About 10,500 of these companies make women's clothes. Most clothing manufacturers have small factories. These firms employ an average of fewer than 100 people, though some have as many as 1,000 workers.

Clothing materials include many natural and artificially created substances. People have used some materials, such as animal furs, for clothes for thousands of years. Other materials, including plastic sheeting and artificially created fibres, came into practical use during the 1900's.

Natural materials include fur, leather, and cloth that is made of plant or animal fibres.

Fur and leather provide many of the warmest and longest-wearing clothes. They are also used in some of the most expensive, fragile, and luxurious garments. Fur comes only from warm-blooded animals. Leather is obtained from either warm-blooded or cold-blooded animals.

Fur is used mostly for coats and coat linings. Such furs as *mouton*, a fur made of sheepskin, make warm coats that wear well. Chinchilla fur is soft, fragile, and not so warm as other furs. Most furs are dyed, plucked, sheared, or treated in some other way before being made into clothes. See **Fur**.

Most leather is used to make shoes. Such items as gloves and handbags—and some jackets, trousers, skirts, and suits—are also made of leather. Tanners manufacture leather by treating hides to make them soft and flexible and to prevent them from rotting. Most leather that is used for clothing is made from cowhide. See **Leather**.

Cotton, flax, silk, and wool are the natural fibres most widely used in clothing. They are long and flexible and can easily be made into thread. Cloth made from each of these fibres has a special quality that makes it popular. Silk has great lustre and softness, for example, and wool provides warmth.

Threads of cotton, flax, silk, and wool fibres are usually knitted or woven into fabric (see **Knitting**; **Weaving**). Such methods as braiding and lace making are occasionally used to make clothing materials. Wool can be made into felt by pressing and rubbing together warm, damp wool fibres. Other kinds of fibres do not stick together when pressed unless they have been treated with an adhesive substance.

Cotton fibres come from the *boll* (seed pod) of the cotton plant. Fibres from the stem of the flax plant are woven into linen. Silk, the strongest of all natural fibres, comes from cocoons spun by silkworms. Sheep provide most of the wool that people use, though such animals

as the alpaca and various breeds of goats also furnish wool. See **Cotton**; **Linen**; **Silk**; **Wool**.

Manufactured materials include paper, plastic sheering, rubber, and artificially produced fibres. Clothing manufacturers are using more of these materials because they have certain advantages over natural ones. For example, many are stronger, more shrink-resistant or less expensive than natural fibres.

In 1884, a French chemist and inventor named Hilaire Chardonnet patented the first successful artificial fibre. He called it *artificial silk*. Chardonnet's fibre was first manufactured in the United States in 1910. It was named *rayon* in 1924. Since then, scientists have developed many other artificial fibres, sometimes called *synthetics*. Chemists develop them from natural substances or by combining two or more chemical compounds. Other synthetics include nylon and polyester.

Today, many widely used fabrics are blends of natural and synthetic fibres. For example, such fabrics could be a mixture of cotton and polyester or wool and nylon. These fabrics have the characteristics of each fibre used in the blend. A fabric made of wool and nylon is warm because of the wool and is shrink-resistant because of the nylon content. See **Synthetics** and its list of *Related articles*.

Paper, plastic sheeting, and rubber have been used less in clothes than have synthetic fibres, but their use is increasing. Some paperlike fabrics are made of fibres held together by adhesive substances. Others are made by combining synthetic fibres with natural fibres or rayon. The synthetics melt when heated and hold the network of fibres together as a fabric. Such fabrics are widely used in making disposable nappies, which are thrown away after being soiled once. Paperlike fabrics are also used for other disposable garments, including bibs, underwear, and rainwear. Manufacturers use plastic sheeting in making such products as handbags, raincoats, and shoes. Rubber is used chiefly to make such flexible, long-lasting, waterproof clothing as boots and gloves.

Ready-to-wear clothes. Most clothes worn today are ready-to-wear garments. Mass production of clothing saves customers both the time it would take to make clothes themselves and the money they would spend on clothes made by a dressmaker or tailor.

Designing is the first step in the manufacture of ready-to-wear clothing. Fashion designers in London, New York City, Paris, and Milan create most clothing styles. They work under great pressure to produce designs—especially of women's fashions—that people will want to buy.

Many large clothing manufacturers employ their own designers. These experts create styles in addition to those that come from Paris and the other fashion centres. Manufacturers try to sell the designs to buyers from clothing stores. Most smaller clothing manufacturers purchase designs from independent designers, as do firms that produce garments which change little in fashion.

After a designer has an idea for a style, he or she chooses the colours and types of fabrics in which to make the garment. The designer then makes samples of

the garments, and buyers from stores come to see them. If the buyers see a style they think will be popular, they order garments of that design.

The final test for any style comes when the clothes appear in stores. If enough people buy a particular style, stores will reorder it from the manufacturer. If customers ignore a style, it soon disappears—and another style takes its place.

Manufacturing and selling. After receiving orders from stores for a certain design, the manufacturer cuts patterns of the garment in various sizes. Ready-to-wear clothes come in standard sizes for different ages and figure types.

Clothing manufacturers buy fabrics in large rolls called *bolts*. Expert examiners unroll the bolts of material and inspect them for rips or other flaws. *Spreaders* pile the bolts on large tables. Workers called *markers* outline each pattern in chalk on the material. In some companies, the markers transfer pattern markings to a large piece of paper that serves as a guide for cutting the material.

Next, workers called *cutters* use electric cutting machines or hand cutting tools to cut out the various parts of the garments. Then *sorters*, who also are called *assemblers* or *bundlers*, number the pieces of material. These employees put all the pieces needed to make one garment in a bundle, along with the necessary buttons and trimmings. The bundles are then sent to the sewing room.

Most sewers handle only one or two parts of a garment. For example, one sewer may stitch only the shoulder seams and hems. Another sewer may make pockets and collars. On some elaborate, expensive coats, dresses, or suits, one person may do all or most of the sewing by hand. *Finishers* do all the outside stitching, such as making buttonholes. *Pressers* iron the garments once they are completed.

Some clothing companies handle all the steps in the manufacture and distribution of their products. Others



Ready-to-wear clothes come in a wide variety of styles, colors, and fabrics. Most clothes bought today are of this type.

send their cut garments to clothing *contractors*, who sew them together and return them to the manufacturer. Sometimes clothing *jobbers* buy cut garments and complete the manufacturing and distribution process. Manufacturers sell most garments directly to retail stores. They may also sell to wholesale dealers, who in turn sell to retailers.

Protecting the public. In many countries, laws protect the public in the purchase of clothing. For example, these laws generally require clothing manufacturers, wholesalers, and retailers to cooperate with textile manufacturers in placing accurate labels on all garments offered for sale.

Labels on wool fabrics are generally required to contain information about the kind and amount of wool used. In addition, a manufacturer might be required to state on the label if a new product is made from wool that is *reused* (when wool fibre from a garment that has been worn is shredded up and made into yarn or fabric), or *reprocessed* (when the wool has been made into a fabric before but not used in a garment that was actually worn). Labels on garments made from fibres other than wool are generally required to show fibre content by percentage. Labels on fur products may identify the type of animal fur and tell if it has been bleached or dyed. Other laws prohibit the sale of fabrics that burn easily.



Fire-retardant materials are often used in the manufacture of children's clothing, especially coats and night wear.

Working in the clothing industry. The clothing industry provides work for engineers, artists, designers, illustrators, writers, teachers, salespeople, and many others.

Fashion designers hold important positions in the clothing industry. The sale of a garment depends largely on the popularity of its design. In turn, the jobs of many people and the profits of many companies depend on the work of designers. People who wish to become fashion designers may take fashion-designing courses in college or attend special design schools.

A successful fashion designer may have special personal qualifications or talents. In addition, most designers know how to drape and sketch new styles, draw and cut patterns, and sew garments. Many designers start their careers as assistants in design departments, as sample makers, or as artists in pattern houses. In time, some designers establish their own firms or form partnerships with other designers.

Fashion coordinators perform a variety of jobs. For example, they may plan an entire fashion show or select the shoes that a model wears for an advertisement. Most large department stores employ fashion coordinators who select merchandise, plan displays, and promote sales. For such work, a person must have a thorough knowledge of current fashion trends.

Fashion writers and artists specialize in describing or illustrating clothes for advertisements and articles in magazines and newspapers and for direct-mail advertisements. They may work for advertising agencies, department stores, manufacturers, publications, or wholesalers. Experts called *copywriters* prepare the written material for clothing advertisements. They must have a talent for writing and a knowledge of clothing design.

Fashion editors decide what current fashions will appear in their publications. They may travel to Paris or other fashion centres to attend fashion shows. These editors must know what types of displays will catch a reader's attention, and they should be able to forecast trends.

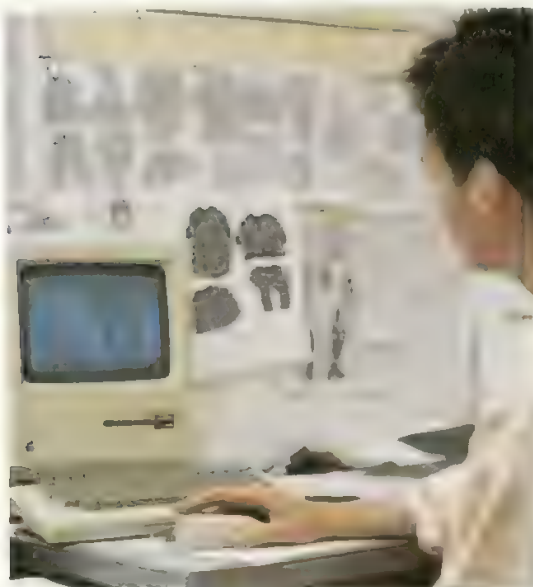
Fashion illustrators need some knowledge of clothing construction in addition to a talent for drawing. Fashion photographers must know how to work with fashion models and arrange merchandise attractively as well as how to use camera equipment.

Garment manufacturing. Men and women who are interested in making clothes may become cutters, dress-makers, finishers, sewing-machine operators, or tailors. They must be able to work quickly and skilfully with their hands. Most garment makers start in training positions under experienced workers. People with training in business management or industrial engineering may find opportunities in garment-manufacturing plants as production managers or plant engineers.

Merchandising. Qualified people may find positions with stores as buyers, department heads, or salespeople. Many men and women open their own small retail clothing shops.

A number of colleges and business schools offer specialized management courses that provide training for merchandising positions. Most large department stores offer management-training programmes to college graduates and occasionally to experienced members of their staffs.

Teaching. Men and women with enough college training may qualify to teach school or college courses related to clothing. Teaching specialties include clothing design, the history of clothing, the merchandising of clothes, and the importance of clothing in society.



A fashion designer uses computer graphics to create original clothing designs. Printouts of various designs are hanging on the wall behind the computer.



Dressmakers learn their trade by working with plastic figures called mannequins. By using a mannequin, a dressmaker can adjust a garment to fit the shape of the human body.

Related articles in *World Book*. See the section of the many country articles in which clothing is discussed, such as **Japan** (Way of life). See also the following articles:

Articles of clothing

Fez	Moccasin
Glove	Necktie
Handkerchief	Shoe
Hat	Stockings
Helmet	Turban

Clothes making and care

Dry cleaning	Sewing
Dye	Spinning
Fashion	Textile
Knitting	Weaving

Clothing materials

Acrylic	Leather
Broadcloth	Linen
Brocade	Mohair
Calico	Muslin
Camel's-hair cloth	Net
Cambric	Nylon
Canvas	Percale
Cashmere	Polyester
Chenille	Rayon
Corduroy	Satin
Cotton	Serge
Damask	Silk
Denim	Swiss
Felt	Synthetics
Flannel	Taffeta
Fur	Tweed
Gabardine	Velvet
Gingham	Voile
Jersey	Wool
Khaki	Worsted
Lace	

Clothing in history

Colonial life in America	Pioneer life in Australia and New Zealand
Egypt, Ancient (Food, clothing, and shelter; pictures)	Renaissance (pictures)
Gauntlet	Roaring Twenties (pictures)
Greece, Ancient (Food, clothing, and shelter; pictures)	Rome, Ancient (Food, clothing, and shelter; pictures)
Indian, American (Clothing; pictures)	Toga
	Tunic

Other related articles

Arabs (Clothing; pictures)	Jewellery
Batik	Modelling
Button	Needle
Climate (Clothing and climate)	Pin
Easter (Wearing new clothes)	Sewing
Embroidery	Sewing machine
Fibre	Strauss, Levi
Fire brigade	Tartan
Flax	Thread
Hairdressing	Twill
	Zip

Outline

I. Why people wear clothes

- Protection
- Communication
- Decoration

II. Clothing around the world

- Why clothing varies
- Traditional costumes

III. Clothing through the ages

IV. The clothing industry

- Clothing materials
- Ready-to-wear clothes
- Protecting the public
- Working in the clothing industry

Questions

What are the three main reasons for wearing clothes?
What improvements did the *spinning jenny* and the *spinning mule* bring to the manufacture of cloth?
What advantages do synthetic fibres have over natural ones?
When did people learn to make yarn and cloth?
How do customs influence clothing styles?
What cities rank as the world's chief clothing centres?
Who were among the first peoples to wear fitted clothes?
Why does clothing vary in different parts of the world?

Clotho. See Fates.

Cloud is a mass of small water droplets or tiny ice crystals that floats in the air. Fluffy white clouds floating across a blue sky, or the colours of clouds at sunset, are part of the beauty of nature. Clouds also play an important part in the earth's weather. The water that they bring as rain and snow is necessary to all forms of life. Clouds can also bring destruction or even death, in the form of hail or tornadoes.

Some clouds are great fleecy masses, and others look like giant feathers. Still others are dull grey or black sheets that darken the earth. Most clouds change shape continually. They do so because parts of the cloud evaporate when mixed with air that is drier than the cloud. Cloud shapes also change because of the action of winds and air movements.

Most planets are covered by clouds. The atmosphere of Venus and of the *Jovian* planets (Jupiter, Saturn, Uranus, Neptune) are entirely opaque, while most of the surface of Mars remains visible.

Kinds of clouds

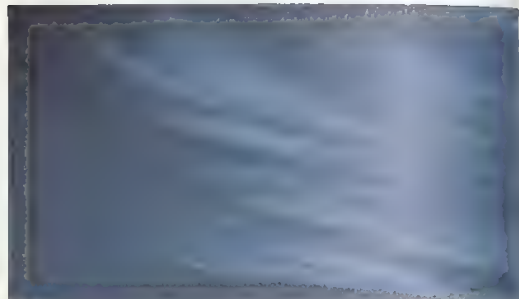
Scientists give names to clouds that describe their appearance. For example, the prefix *strato-* means *layerlike* or *sheetlike*. Clouds that appear as layers or sheets are called *stratus* clouds. The prefix *cumulo-* means *pile* or *heap*, and *cumulus* clouds are piled-up masses of white clouds. The prefix *cirro-* means *curl*, and *cirrus* clouds are curly white clouds. These terms and a few others are used to form the names of the most common clouds. The various types of clouds are grouped into different classes according to their height above the ground.

Low clouds. Two kinds of clouds, *stratus* and *strato-cumulus*, are usually seen near the earth. The *bases* (lower edges) of most of these clouds are less than 1,800 metres above sea level. A stratus cloud looks like a smooth, even sheet. Drizzle often falls from it. A strato-cumulus cloud is not as even in thickness as a stratus cloud. It has light and dark areas on the bottom, indicating, as its name suggests, that there are piles of clouds in the layer.

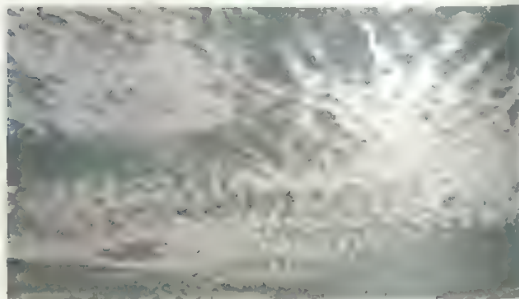
Middle clouds, called *altostratus*, *altocumulus*, and *nimbostratus*, usually lie from 1,800 to 6,000 metres above the earth. Nimbostratus clouds sometimes may be closer to the ground. An altostratus cloud forms a smooth white or grey sheet across the sky. If the cloud is not too thick the sun may be seen through it. An alto-



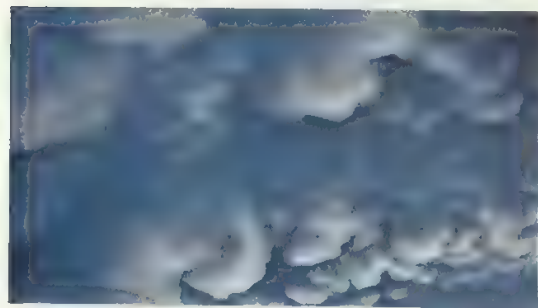
A towering cumulus cloud may rise to great heights and may develop into a cumulonimbus cloud that brings a thunderstorm.



High cirrus clouds look like tufts of hair. They are so high and cold that the water they contain is frozen into ice crystals.



Medium-high altocumulus clouds, above, may appear as small cloud patches arranged in bands or irregular groups.



Some cumulonimbus clouds have rounded bumps on their undersides. Tornadoes sometimes come from these clouds.



Low stratus clouds cover the sky with a thick, even blanket. These clouds usually bring rain or snow.

cumulus cloud appears in many shapes. It may be seen as unconnected piles or as a layer of clouds piled together. A nimbostratus cloud is a smooth layer of grey. Frequently, the cloud itself cannot be seen because of the rain or snow that is falling from it.

High clouds, called *cirrus*, *cirrostratus*, and *cirrocumulus*, are formed entirely of ice crystals. Other clouds are mainly water droplets. Cirrus clouds are the delicate wispy clouds that appear high in the sky, sometimes higher than 10,000 metres. A cirrostratus cloud is a thin sheet of cloud. It often causes a halo to appear around the sun or moon. This halo is a good way to recognize a cirrostratus cloud. Cirrocumulus clouds look like many small tufts of cotton hanging high in the sky.

Clouds at more than one height. *Cumulus* and *cu-*

mulonimbus clouds may rise to great heights while their bases are near the ground. Cumulus clouds are heaped-up piles of cloud. They may float lazily across the sky or change into the most spectacular of all clouds, the cumulonimbus. A cumulonimbus cloud may reach heights as great as 18,000 metres from its base. Its top, which contains ice crystals, spreads out in the shape of an anvil. This kind of cloud is often called a *thunderhead* because heavy rain, lightning, and thunder come from it. Sometimes hail or, on rare occasions, a deadly tornado comes from a cumulonimbus cloud.

How clouds form

Clouds form from water that has evaporated from lakes, oceans, and rivers, or from moist soil and plants.



Cirrus fibratus and cirrus floccus clouds are thicker than the wispy cirrus clouds, and cover larger areas of the sky.



Altostratus undulatus clouds, above, form bands across the sky. The gaps between the bands may be wide or narrow.



Stratocumulus clouds cover the sky with large, rounded masses within a few thousand feet of the ground.

This evaporated water, called *water vapour*, expands and cools as it rises into the air. Air can hold only a certain amount of water vapour at any given temperature. Warm air can hold more water vapour than cool air can. When the temperature drops, some of the water vapour begins to *condense* (change to a liquid) into tiny water droplets.

For water vapour to condense, particles so small they can be seen only through a microscope must be present. These particles, called *condensation nuclei*, become the centres of the droplets. Many condensation nuclei are tiny salt particles or small particles present in smoke. Most droplets measure from 0.01 to 0.1 millimetre in diameter.

If the temperature is cold enough, and other condi-



*Scale indicates altitude in thousands of metres.

Different clouds are seen at various altitudes above the earth. This diagram shows examples of some common clouds and their approximate altitudes. Many clouds are found only within a certain range of altitudes. Other clouds, such as the cumulonimbus, extend from very low to very high altitudes.

tions are right, water vapour does not condense to form a liquid droplet. Instead, the water vapour turns directly into ice through a process called *sublimation*. For sublimation to occur at temperatures above -40°C , small particles similar to condensation nuclei, with a shape somewhat like an ice crystal, must be present. These particles are called *freezing nuclei*.

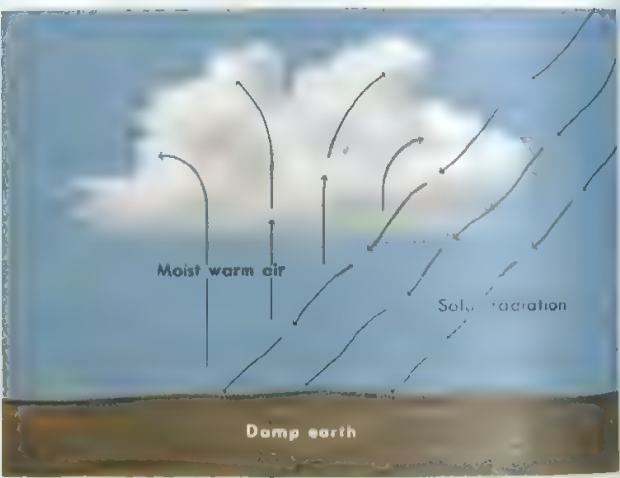
A cloud often contains both water droplets and ice particles if the temperature is between 0° and -40°C . Water droplets do not always freeze at the normal freezing temperature of water, 0°C . They may remain liquid down to a temperature of -40°C .

Rain or snow forms when water evaporates from the liquid droplets and freezes on an ice crystal. The crystal grows larger until it falls out of the cloud. It falls to earth

How clouds form

Clouds form when moist air rises and becomes cooler. The air usually rises by (1) convection, (2) lifting, or (3) frontal activity. Cool air cannot hold so much water vapour as warm air can, and the excess vapour changes into tiny drops of water or crystals of ice, which form clouds.

By convection. Solar radiation heats the ground and the air next to it, *right*. The warm air becomes lighter and *convection* (a flow of air) carries it upward. As the air rises, it becomes cooler. If the air is moist, some water vapour condenses and forms clouds, such as the cumulus clouds shown below.



By lifting. Warm, moist air blowing over mountains or hills is lifted, *right*. When the air rises, it cools and cannot hold all its water vapour. This vapour *condenses* (changes to drops of liquid) and forms clouds over the high ground, *below*. Clouds formed in this way cover the tops of some mountains permanently.



By frontal activity. A weather front occurs when two masses of air at different temperatures come together. The diagram, *right*, shows cool air moving under warm air along a cold front. The warm air is cooled as it rises above the cool air. Many clouds form, *below*, along the front at all altitudes.



as a snowflake unless it enters a layer of air where the temperature is above freezing. Then the snowflake melts and becomes a raindrop.

Water vapour can rise to form clouds in several ways. When the sun warms the ground, the air next to the ground is heated. Because warm air is lighter than the same volume of cooler air, the warm air rises. This rise of warm air is called a *convection current*, and this method of cloud formation is called *convection*. As the air rises, it expands and becomes cooler. If enough water vapour is in the expanding air, the vapour will condense and form clouds.

Clouds also form by *lifting*. When warm, moist air moves up the side of a hill or over a mountain range, it is lifted and cools by expansion. This cooling causes the water vapour to condense and form clouds that hang over the mountains.

Weather fronts, which form where masses of warm and cool air meet, produce clouds by *frontal activity*. The water vapour in the rising warm air becomes cooler and condenses, creating the water droplets that form clouds.

Clouds and the weather

Storms. Weather forecasters study clouds carefully because certain types often appear before storms. In many cases, a warm front or a low pressure system may be identified by these clouds, which form in a definite order over several days. First, a few wispy cirrus clouds appear in the west. Soon more appear and gradually merge into cirrostratus clouds that cover the sky. The cirrostratus clouds are later hidden by a lower layer of altostratus clouds that becomes thicker and hides the sun. Light rain or snow may begin to fall from the altostratus layer. The base of the clouds becomes still lower as nimbostratus clouds move in with heavier rain or snow. Cumulus and cumulonimbus clouds often develop within the nimbostratus ones. As a result, the rain may include heavy showers.

As the storm moves past, the rain or snow ends but the sky remains overcast with stratocumulus clouds. These low clouds disappear when fair weather returns.

A cold front brings clouds in a different order. Often, both middle and high clouds come before the front. The most striking feature of most cold fronts is a wall of large cumulus or cumulonimbus clouds along the advancing edge of cold air. As this wall passes overhead, the temperature falls. Heavy showers may also occur, and in the Northern Hemisphere, the direction of the wind usually shifts from the south to the northwest. After the line of clouds passes, many cumulus or stratocumulus clouds may remain for a short time. Clearing weather then occurs rapidly.

In summer, it is often possible to watch a thunderstorm form. The sky may be clear in the morning, or a few altocumulus clouds might be present. As the earth becomes warmer, small cumulus clouds appear and begin to grow. These clouds may become large, towering cumulus clouds that bring a little rain. As the towering cumulus clouds continue to grow, an anvil of clouds spreads out at the top and extends ahead of the main clouds. The clouds are now cumulonimbus, and a thunderstorm usually follows.

Heating and cooling of the earth are also influenced

by clouds. Most cloudy days are cooler than clear days because the clouds reflect much sunlight back into space. This reflected sunlight does not heat the earth. On the other hand, clouds have an opposite influence on the earth's temperature at night. The earth gives off heat toward space, causing the ground to cool off. Clouds intercept much of this heat and send it back toward the ground. For this reason, most cloudy nights are warmer than clear nights. The heat is trapped in the lower layer of air between the cloud and the ground. Therefore, low clouds trap much more heat than do higher clouds.

Related articles in *World Book* include:

Cloudburst	Rainmaking
Fog	Water (picture):
Lightning	The water cycle)
Rain	Weather

Cloud chamber, Wilson. See Wilson cloud chamber.

Cloud seeding. See Rainmaking.

Cloudburst is a sudden heavy rain falling for a short period of time in a small area. Cloudbursts are usually associated with thunderstorms. They occur most often in desert and mountain regions, and in the interiors of continents. The uprushing air currents of a thunderstorm support a large amount of water in the form of raindrops. If the air currents are suddenly cut off, the mass of rain quickly falls out over a small area. Stream beds become torrents, and rivers form in valleys that are usually dry. During a cloudburst, more than 2.5 centimetres of rain may fall in 15 minutes. See also **Cloud**; **Rain**; **Weather**.

Clough, Arthur Hugh (1819-1861), was a British poet and scholar. The best-known of his long poems is "The Bothie of Tober-na-Vuolich" (1848), which tells of an Oxford undergraduate's love for a Scots girl. Clough's shorter poems include "Say Not the Struggle Nought Availeth."

Clough was born in Liverpool, England, and spent part of his childhood in the United States. He returned to Britain to school, and later graduated from Oxford University. His literary friends included Benjamin Jowett and Matthew Arnold. Clough's death was commemorated by Matthew Arnold in his poem "Thyrsis."

Clove is the name given to the dried flower buds of a tropical tree belonging to the myrtle family. The dried



Clove trees grow in regions that have a warm, wet climate. The trees reach a height of 4.5 to 9 metres.



Cloves, the flower buds of the clove tree, are reddish when picked. Dried cloves, which are used as a spice, are dark brown.

buds are used as spices. The name comes from the French word for *nail* because of the shape of the flower bud. The clove tree grows wild in parts of Indonesia and the West Indies. It is grown as a crop in Indonesia, Madagascar, and Tanzania.

The clove tree, an evergreen, grows 4.5 to 9 metres tall. The large, smooth, oblong leaves taper to a point. The tree's purplish flowers grow on jointed stalks. The buds of these flowers, called *cloves*, are picked before they open. They are reddish when picked, but turn dark brown when dried. Cloves have a fragrant odour and a warm, sharp taste. They are used chiefly in cooking. An oil from the clove tree's buds and stem is used to flavour desserts and sweets. This oil is also used to scent soaps.

Scientific classification. The clove tree belongs to the myrtle family, Myrtaceae. Its scientific name is *Syzygium aromaticum*.

Clover is a valuable crop used to feed farm animals and to enrich the soil. It contains large amounts of protein and minerals. Clover is used for pasture and to make hay and silage. In addition, clover enriches the soil by adding more nitrogen to the soil than the plant needs for growth (see Nitrogen (Nitrogen and life)). Bacteria that live in clover's roots take nitrogen from the air for the plant's growth and health. Clover uses only some of the nitrogen. After farmers plough clover into the soil, the rest of the nitrogen becomes part of the soil and can be used by other plants.

Clovers are *legumes* (members of the pea family). There are over 300 kinds of true clovers, including the *red*, *white*, *strawberry*, and *crimson* species. A type called *subterranean clover* has burrs that bury themselves underground. Sweet clover and certain other plants in the pea family are sometimes called clovers. However, botanists do not classify these plants in that group.

The various clovers differ in the manner in which they grow. Some species are *annuals*—that is, they live for only one growing season. Others are *perennials* and can live for more than two growing seasons without being replanted. Species of clover also differ in appearance. They range from 15 to 90 centimetres in height, and have leaves that consist of three to six leaflets. Some people believe that four-leaf clovers bring luck. The plants produce clusters of tiny flowers that are white, yellow, or any of various shades of red. The number of

flowers in each cluster varies from one species to another, ranging from 5 to 200.

Clover probably originated in southwestern Asia Minor and southeastern Europe. Today, both wild and cultivated species of clover plants grow throughout the world.

Red clover has been used for centuries as a rotation crop. Today, it is used extensively as an animal food and soil-improving crop throughout Europe and northern and central North America. Red clover is generally planted with another crop, such as oats, barley, wheat, grasses, or certain legumes. It has purplish-red flowers and lives for two to three years.

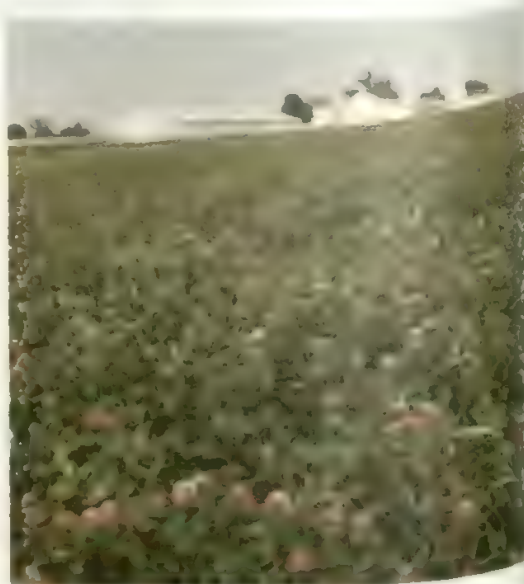
There are three types of red clover—early flowering, late flowering, and wild. Early flowering red clover produces two to four hay crops a year.

White clover has white or pinkish-white flowers. Its stems spread along the ground and take root in the soil at each *node*, the place where a leaf joins the stem. The roots are short and so cannot reach water far underground. As a result, white clover is grown in regions that have an abundant supply of water.

Strawberry clover is a valuable pasture crop, especially in areas that have extremely wet and salty soil. Other pasture crops cannot survive in such soil. Strawberry clover has pink flowers that grow in strawberry-like clusters.

Crimson clover is widely cultivated. Farmers plant it in the autumn to provide protection against erosion during the winter. They use crimson clover for pasture and hay and to improve the soil. The flowers of this clover are dark red and grow in pointed clusters.

Subterranean clover provides winter and early spring pasture in regions that have mild winters. It is raised chiefly in Australia and Chile and in California and Oregon in the United States. The seeds of subterranean clover form in burrs that bury themselves in the soil. The



A field of red clover provides feed for farm animals. The crop is used for pasture or to make hay and silage. Red clover is also used extensively as a rotation crop.



Varieties of clover differ chiefly in appearance and in the way they grow. The illustration above shows, from left to right, white clover, red clover, strawberry clover, and crimson clover.

plant got its name from this unusual method of growth.

Scientific classification. True clovers belong to the pea family, Leguminosae (Fabaceae). Red clover is *Trifolium pratense*; white clover, *T. repens*; strawberry clover, *T. fragiferum*; crimson clover, *T. incarnatum*; and subterranean clover, *T. subterraneum*. Sweet clover is genus *Mellilotus*.

See also **Flower**; **Lawn** (picture: Lawn enemies); **Legume**; **Lespedeza**; **Shamrock**.

Clovis I (466?-511), a Frankish king, became the first powerful ruler of the Merovingian dynasty, the founders of the French state. In 481, when Clovis inherited the royal title, he was only one of several Frankish kings. Then, in 486, he defeated the last great Roman army in Gaul (Gaul was the name of the land which now includes France, Belgium, and part of Germany). In one campaign after another, he defeated the Alamanni, the Visigoths, and the Burgundians. By 507 he ruled over most of Gaul, western Germany, and the Low Countries of northwestern Europe.

Clovis was the first Germanic king to become an orthodox Christian. Most Germanic rulers either became Arian heretics or remained pagans. By his conversion to

Christianity, Clovis won the support of his Catholic subjects, including the clergy.

See also **Fleur-de-lis**; **Franks**; **Goths**; **Merovingian**; **Salic law**.

Clown is a type of comic performer who usually works in a circus. To make audiences laugh, most clowns wear funny costumes and makeup and behave in a strange or silly manner.

There are two chief types of circus clowns—*auguste* and *whiteface*. Auguste clowns wear extravagant makeup and baggy suits and appear stupid and clumsy. Whiteface clowns are more elegant. They wear white makeup and clown suits and often perform opposite auguste clowns, especially in European circuses. Another type, known as *tramp* clowns, or *hobo* or *Charley* clowns, became popular in American circuses. They resemble tramps, with their tattered suits, unshaven faces, and red noses. They always look sad or lonely.

The first clowns date back to ancient times. They have been called by such names as jester, fool, and buffoon. The word *clown* was popularized in the early 1800's by Joseph Grimaldi, a famous British comic actor.

The circus clown began in the late 1700's as a kind of comedian who stood in front of an audience and told jokes. Because the first circuses were small in size, a single clown could entertain the entire audience with jokes and songs. During that time, clowns ranked among the great stars of the circus. As circuses grew larger in the mid-1800's, individual clowns could no longer entertain audiences. Groups of frolicking clowns replaced the single performing clown. However, in the mid-1900's, such performers as the American tramp clown Emmett Kelly continued the earlier tradition.

See also **Circus** (pictures); **Jester**.

Club moss is any one of a group of plants that look somewhat like large mosses. Actually, club mosses are more closely related to ferns and horsetails than they are to mosses. Club mosses were among the first land plants. They appeared on earth about 300 million years ago. The greatest variety of club mosses grow in tropical regions.

Clowns wear colourful, silly costumes and makeup. Most clowns provide comedy at the circus. They often work in groups, performing comic skits and routines. Many clowns are skilful acrobats, jugglers, and magicians.





Club mosses have erect green stems and tiny leaves. They are not true mosses, but rather are related to ferns and horsetails.

Club mosses have horizontal stems that spread across the soil. The stems produce roots that grow downward and leafy stems that grow upright. The erect stems may have many branches and are covered with small, needlelike green leaves. *Spores* (tiny reproductive cells) grow on enlarged leaves. Most species of club mosses grow only a few centimetres high.

Scientific classification. Club mosses belong to the club moss family, Lycopodiaceae. They make up the genus *Lycopodium*.

See also **Fern; Horsetail; Plant** (picture: Lycophytes). **Clubfoot** is an abnormal condition of the foot, usually present at birth. But it may develop later as the result of injury or poliomyelitis or other diseases. The condition is also called *talipes*. In the commonest form of clubfoot, the foot is bent downward and inward so that the person can walk only on the toes and on the outside of the foot. Sometimes the foot is bent upward and outward so the person can use only the heel for walking. Doctors use massage, manipulate the foot into position, and use casts to hold the corrected position. In severe cases of clubfoot, surgery may be necessary.

Clumber spaniel is a short, heavy hunting dog. It has a white coat with orange- or lemon-coloured markings. The dog is heavy for its size. Males stand about 45 centimetres

high at the shoulder, and weigh about 36 kilograms. Females weigh about 29 kilograms.

The Clumber spaniel was originally bred in France by the dukes of Noailles, and it was introduced into England in the early 1800's by the Duke of Newcastle. It is named after Clumber Park, Nottinghamshire, the ancestral home of the Duke of Newcastle.

Clune, Frank (1893-1971), an Australian writer, became well known for his books of travel, adventure, history, and biography. He was born in Sydney and named Francis Patrick Clune. Wounded at Gallipoli in World War I, he was an honorary major in World War II. His first book was *Try Anything Once: The Autobiography of a Wanderer* (1933). His other works include *Dig* (1937), the story of Burke and Wills, the ill-fated explorers; *Ben Hall the Bushranger* (1947); *Wild Colonial Boys* (1948); *Martin Cash* (1955); *Journey to Pitcairn* (1966); *Scallywags of Sydney Cove* (1968); and *The Scottish Martyrs* (1969).

Clunies-Ross is a family connected with the Cocos Islands in the Indian Ocean. **John Clunies-Ross** (1785?-1854) of Shetland, Scotland, settled with his family in the Cocos Islands in 1827 and imported Malayan labour. His son John George and grandson George (1842-1920) established a legal code and currency, and encouraged the copra industry. The British government transferred the islands to Australia in 1955. The Clunies-Ross family retained ownership of their estate on Home Island until 1978, when the Australian government bought it.

Sir Ian Clunies-Ross (1899-1959) was an Australian veterinary scientist and scientific administrator. He was born in Bathurst in New South Wales. He began his career with the Council for Scientific and Industrial Research (CSIR) in 1926, as a parasitologist. In 1949, the CSIR became the Commonwealth Scientific and Industrial Research Organization, and he became chairman.

Cluskey, Frank (1930-), a Labour Party politician, was minister for trade and commerce in the Republic of Ireland's coalition government during the period 1982-1983. Cluskey was born in Dublin. He joined the Workers' Union of Ireland and became a full-time union official. Elected to Dublin Corporation in 1960, he became lord mayor in 1968.

Cluskey first entered Dáil Éireann (the House of Representatives of the Irish parliament) in 1965. He became Labour's chief whip in 1969. From 1973 to 1977, he was parliamentary secretary to the social welfare minister. He was leader of the Labour Party of Ireland from 1977 to 1981.

Clutch. See **Transmission**.

Clwyd was a county in northeast Wales. It ceased to exist as a local government area in April 1996. The region has an industrial belt in the east and seaside resorts on the northern coast. The southern and western parts of the region are rural, with rolling uplands interspersed by winding valleys. Clwyd takes its name from the Vale of Clwyd, through which flows the River Clwyd.

Clwyd makes up about a tenth of Wales in area and has an eighth of its population. The local government of Wales was reorganized in 1974, and the county of Clwyd was created by combining the old counties of Denbighshire and Flintshire. A small part of western Denbighshire was taken into Clwyd's neighbouring county of Gwynedd. Clwyd took in a small part of what had been Merionethshire



The Clumber spaniel has a low, heavy body.

Facts in brief about Clwyd

Largest towns: Wrexham, Colwyn Bay, Rhyl.

Area: 2,425 km².

Population: 1991 census—401,500.

Chief products: *Agriculture*—dairy farming, grain, market gardening, sheep. *Manufacturing and processing*—aircraft, chemicals, clothing, coated steel, electronics components and consumer goods, glass and optical fibres, paper and paper products, pharmaceuticals, processed food. *Mining and quarrying*—coal, fireclay, limestone, silica.

People and government

About one person in every five people living in Clwyd speaks both Welsh and English. This proportion is slightly higher than the average for Wales. The upland regions and the Vale of Clwyd have a high proportion of bilingual people. In farming areas, especially in the upland regions, speech is almost entirely in Welsh. But in the county's coastal areas and the industrial areas of eastern Clwyd most people speak English. Rural Welsh-speaking areas have *Welsh-medium* primary schools—that is, the language for teaching in these schools is Welsh. See *Welsh language*.

Local government. Clwyd was divided into six local government districts: *Alyn and Deeside*, including Conna's Quay and Hawarden; *Colwyn*, the western part of Clwyd; *Delyn*, including Holywell and Mold; *Glyndŵr*, including Ruthin and southern Clwyd; *Rhuddlan*, including Prestatyn and Rhyl; and *Wrexham Maelor*, including Wrexham and southeastern Clwyd. In April 1996, the county and districts were abolished, and replaced with unitary authorities, each having all local government powers within its own area.

Mold is the only town visited by the crown court. The North Wales Police Force is based at Colwyn Bay.

Economy

Agriculture. Farmers in the fertile valley of the rivers Dee and Clwyd grow mainly cereals. On the hill slopes, farmers carry on dairying or mixed farming. Farmers on the higher moorlands breed sheep and beef cattle. Market gardening is important around Holt. Forestry is extensive in the Clwyd valley, on the Clwydian Range of hills, and on slopes above the River Conway.



Clwyd was a county in northeastern Wales lying alongside the border with England.

Mining and quarrying. Coal mining, once important, has declined in Clwyd. Only one pit, at Point of Ayr, is open. Mining and quarrying in Clwyd produce mainly limestone, silica, and fireclay.

Manufacturing. In 1980, the British Steel Corporation closed down its steelworks at Shotton but coated steel is still produced on the site. Many factories in Clwyd use steel in such items as washing machines. Other important industries in Clwyd include making automotive components, chemicals, clothing, electronic consumer goods, lenses, microprocessors, paper, optical fibres, and plastics.

Tourism. Rhyl, Prestatyn, Colwyn Bay, and Abergele all have fine seaside facilities. Medieval-style feasts are served in historic buildings, such as Ruthin Castle. Caravan sites abound. Other tourist attractions have been developed inland, such as craft centres, heritage trails, and country parks.

Transportation and communication. Clwyd's only railway lines are the main line from Chester to Holyhead and two branch lines running north from Ruabon and Wrexham. Hawarden has a small airport. The A5 and A55 roads pass through Clwyd. The *Liverpool Daily Post*, a daily newspaper published in Merseyside, serves the area.

Land

Location and size. Clwyd lies on the northeastern coast of Wales. To the south and west, it borders on Gwynedd and Powys. To the east, it borders on the English counties of Merseyside, Cheshire, and Shropshire. Clwyd's maximum dimensions are about 65 kilometres from north to south and 55 kilometres from east to west.

Land features. The wide Vale of Clwyd runs north and south between Rhyl and Ruthin. The Hiraethog Moors lie to the west. Their highest point, Bryntrillyn, is 496 metres above sea level. To the east lies the Clwydian Range. Moel Famau is the highest point, at 555 metres. South of Ruthin lie the Berwyn Hills and the Llandegla Moors. Spectacular limestone formations include the Eglwyseg Rocks near Llangollen. Limestone caves are at Cefn Meriadog, near Abergele, and Tremeirchion, near St. Asaph.

The largest rivers are the Clwyd and the Dee. Three lakes on Bryntrillyn serve as reservoirs.

Climate. Annual rainfall ranges from 635 millimetres in the east to nearly three times that in the south. January temperatures average 5 °C. July temperatures average 16 °C.

History

Stone Age people lived in caves at such sites as Cefn Meriadog and Tremeirchion. Bronze and Iron Age sites lie on the Hiraethog Moors and the Clwydian Range. The Romans built a road through Clwyd and mined lead at Prestatyn. Later, Welsh princes ruled several *cantref*s (ancient divisions of a region) in Clwyd. Offa's Dyke, separating Wales from the English kingdom of Mercia, was built in the 700's. It extended from Prestatyn through Brymbo, Ruabon, and Chirk.

Rival Welsh princes battled over disputed areas in Clwyd. Eventually the Normans conquered it and built castles at Flint, Rhuddlan, Mold, Holt, Ruthin, and Denbigh. In 1284, Edward I issued the Statute of Rhuddlan,

forming the cantref of Tegeingl into the *shire* (county) of Flint. In the early 1400s, Clwyd was held for 10 years by the Welsh rebel Owain Glyn Dŵr (Owen Glendower). With the Act of Union of 1536, Denbighshire became a county alongside an enlarged Flintshire. The counties were combined as Clwyd in 1974.

Clyde, River, is the chief commercial waterway in Scotland. The River Clyde rises in the Southern Uplands of Scotland and flows northward for 160 kilometres. It empties into the Firth of Clyde, along the west coast. The Falls of Clyde near the town of Lanark, Strathclyde Region, once furnished the power for many mills in the Lowlands. Shipbuilding yards line the river's banks in Glasgow, the largest city in Scotland. The *Queen Mary*, *Queen Elizabeth*, and other famous ships were built there. Below Glasgow, the river widens into the Firth of Clyde, an inlet of the sea (see **Firth of Clyde**).

Clydebank (pop. 44,658) is a local government district in Strathclyde Region, Scotland. It extends westwards from the Glasgow city boundary along the north bank of the River Clyde. It is formed from the former burgh of Clydebank and the villages of Duntocher, Hardgate, and Old Kilpatrick. Shipbuilding became the district's most important industry in the late 1800s. The *Queen Mary* and the two vessels called *Queen Elizabeth* were among the ships launched from yards in Clydebank. By the 1980s, shipbuilding had declined. Clydebank's present industries include the production of oil-drilling equipment and gas turbines. The district also produces whisky and tobacco. In 1981, Clydebank was designated as an *enterprise zone*, which made it attractive to many new industries. See also **Strathclyde Region**.

Clydesdale (pop. 57,078) is a local government district in southeastern Strathclyde Region, Scotland. It is a rural area in which fruit and vegetable growing are the main economic activities. Sheep graze on the bleak moorlands and hills in the south of the district. Clydesdale's administrative centre is the town of Lanark. It has sand and gravel deposits nearby, which are worked commercially. Clydesdale also has a variety of light industries. See also **Strathclyde Region**.

Clydesdale. See **Horse** (Draught horses; picture).

Clytemnestra was a princess in Greek mythology. She married Agamemnon, king of Mycenae, and her sister Helen married his brother Menelaus. Clytemnestra bore a son, Orestes, and three daughters, Iphigenia, Electra, and Chrysothemis. Agamemnon sacrificed Iphigenia to obtain a favourable wind from the gods for the Greek fleet sailing to attack Troy (see **Trojan War**). Clytemnestra hated Agamemnon for sacrificing their daughter and waited for 10 years until the end of the war to take revenge. While awaiting Agamemnon's return, Clytemnestra fell in love with his cousin Aegisthus. When her husband came back from Troy, Clytemnestra and Aegisthus killed him. Orestes avenged his father's death by killing Clytemnestra and Aegisthus.

See also **Agamemnon**; **Orestes**.

Cnidarian is the name of a group of soft-bodied water animals. The group includes the freshwater hydras, hydroids, jellyfish, sea fans, sea anemones, and corals. These animals make up the *phylum* (large group) called *Cnidaria*. There are approximately 9,000 species of cnidarians, and most of them live in the sea. Cnidarians are also called *coelenterates*.

The body of a cnidarian may be shaped like a cylinder, a bell, or an umbrella. The mouth opens at one end and leads to a digestive cavity. Every cnidarian has at least two layers of cells that form its body wall. An outer layer makes up the body covering, and an inner layer lines the digestive cavity. Many cnidarians have a third, or middle, layer consisting of a stiff, jellylike material that helps support the animal.

A *medusa*, or jellyfish, is a cnidarian that has a bell- or umbrella-shaped body. Its mouth is at the underside of the body. Tentacles with special stinging cells hang downward from the body's ringlike edge. Medusas swim about freely in the sea.

A *polyp* is a cnidarian that has a body shaped like a hollow cylinder. A polyp lives with one end of its body attached to the sea bottom. The mouth and tentacles extend upward at the other end. Polyps may exist singly or may live together in colonies. Colonies are produced when polyps form buds that detach and become new polyps. Hydras and sea anemones are examples of single polyps, and hydroids and most corals are colony-forming polyps.

Some cnidarians have either medusa or polyp stages, or both, in their life cycles. The medusas are produced from special polyp buds that eventually break free and swim away. Then the medusas produce eggs and sperm that unite and develop into polyps.

Related articles in World Book include.

Coral	Portuguese man-of-war
Hydra	Sea anemone
Jellyfish	Sea fan

Cnossus. See **Knossos**.

Cnut. See **Canute**.

Coach was the name for a four-wheeled vehicle drawn by animals. Coaches served as the main means of public travel before the development of railways. They were usually pulled by horses, and carried passengers, mail, and express freight. The word *coach* comes from *Kocs*, a town in Hungary where an early coachlike vehicle was built in the 1450s. Emperor Frederick III of Germany built one of the first real coaches in 1474. The name can now be used for some buses, and for railway cars that carry passengers.

Coaches developed from the two wheeled wagons and carts people had used since the time of the ancient Egyptians over 5,000 years ago. Their use spread throughout Europe during the 1500s. The first public coach line in England began about 1640.

See also **Stagecoach**; **Wagon**.

Coach dog. See **Dalmatian**.

Coagulant is any substance that causes a fluid to clot, or thicken. Milk curdles because *rennin*, an enzyme, causes clots to form. One of the most important coagulant actions is the clotting of blood. Scientists have found many blood-clotting factors. The combined action of all of them produces a blood clot. If any one factor is missing, the tendency for blood to clot is reduced. Doctors then try to supply the missing substance. In the blood disease *haemophilia*, doctors use an antihæmophilic globulin to help the blood to clot. In other diseases, they may give the patient vitamin K or fibrinogen to induce the blood to clot and control haemorrhages.

See also **Anticoagulant**; **Blood** (Controlling bleeding); **Fibrin**; **Haemophilia**; **Vitamin** (Vitamin K)



Fossil ferns and a lump of coal, left, were both formed from the remains of plants that died many millions of years ago. While the plants lived, they stored up energy from the sun. The plants that became fossils gave up their store of energy in the process. Only the outline of their appearance remains. But the energy of the coal-forming plants is preserved in the coal. When the coal is burned, it releases this energy in the form of heat.

Coal

Coal is a black or brown rock that can be ignited and burned. As coal burns, it produces energy in the form of heat. The heat from coal can be used to heat buildings and to make or process various products. But the heat is used mainly to produce electricity. Coal-burning power plants supply nearly half of the electricity used throughout the world. Coal is also used to make *coke*, an essential raw material in the manufacture of iron and steel. Other substances obtained in the coke-making process are used to manufacture such products as drugs, dyes, and fertilizers.

Coal was once the main source of energy in all industrial countries. Coal-burning steam engines provided most of the power in these countries from the early 1800's to the early 1900's. Since the early 1900's, petroleum and natural gas have become the leading sources of energy throughout much of the world. Unlike coal, petroleum can easily be made into petrol and the other fuels that are needed to run modern transportation equipment. Natural gas is often used in place of coal to provide heat. But the world's supplies of petroleum and natural gas are being used up rapidly. If they continue to be used at the present rate, petroleum and natural gas supplies may be exhausted by 2050. By contrast, the world's supply of coal can last more than 250 years at the present rate of use.

Increased use of coal, especially for producing electricity, could help relieve the growing shortage of gas and oil. However, the use of coal involves certain prob-

lems. The burning of coal has been a major cause of air pollution. Methods have been developed to reduce the pollution, but these methods are costly and not yet fully effective. They must be improved before the use of coal can be increased greatly. In addition, some coal lies deep underground and so is difficult to mine.

In the past, few jobs were harder or more dangerous than that of an underground coal miner. During the 1800's, many miners had to work underground 10 or more hours a day, six days a week. Picks were almost the only equipment they had to break the coal loose. The miners shovelled the coal into wagons. In many cases, children as young as 10 years of age hauled the coal from the mines. Women worked as loaders and haulers. Over the years, thousands of men, women, and children were killed in mine accidents. Thousands more died of lung diseases from breathing coal dust throughout their working lives.

Today, machines do most of the work in coal mines. Mine safety has been improved, work hours have been shortened, and child labour is prohibited. The death rate from mine accidents has dropped dramatically since 1900. However, coal mining remains a hazardous occupation.

This article discusses how coal was formed, where it is found, its uses, and how it is mined. The article also discusses the cleaning and shipping of coal, the coal industry, and the history of the use of coal throughout the world.

Coal developed from the remains of plants that died 400 million to 1 million years ago. For this reason, it is often referred to as a *fossil fuel*. The coal-forming plants probably grew in swamps. As the plants died, they gradually formed a thick layer of matter on the swamp floor. Over the years, this matter hardened into a substance called *peat*. In time, the peat deposits became buried under sand or other mineral matter. As the mineral matter accumulated, some of it turned into such rocks as sandstone and shale. The increasing weight of the rock layers and of the other overlying materials began to change the peat into coal. Coal, sandstone, and other rocks formed from deposited materials are called *sedimentary rocks*.

The first stage in the formation of coal produces a dark brown type of coal called *lignite*. Lignite develops from buried peat deposits that have been under pressure. The pressure results from the weight of the overlying materials and from movements within the earth's crust. As the pressure increases, lignite turns into *subbituminous coal*. Under greater pressure, subbituminous coal turns into a harder coal called *bituminous coal*. Intense pressure changes bituminous coal into *anthracite*, the hardest of all coals. Bituminous coal is also known as *soft coal*; anthracite, as *hard coal*.

Anthracites are the oldest coals in most cases, and lignites are the youngest. Some anthracites began to form as long as 400 million years ago. Some lignites developed within the last 1 million years. The greatest period of coal formation occurred during a time in the earth's history called the *Carboniferous Period*, from about 360 million to 290 million years ago. Swamps covered much of the earth during this period. Tall ferns and other treelike plants grew in the swamps and produced huge amounts of peat-forming matter after they died. Today's plentiful deposits of bituminous coal developed largely from the vast peat deposits formed during the Carboniferous Period. It took about 1 to 2 metres of compact plant matter to produce a bed of bituminous coal 0.3 metre thick.

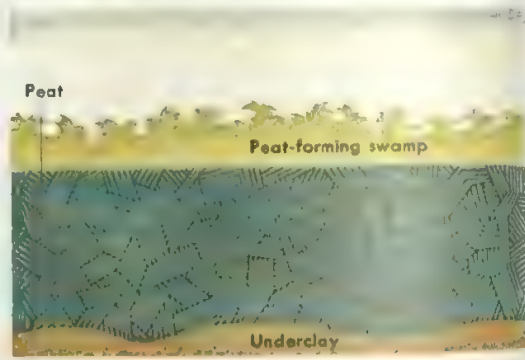
Plant materials are still accumulating in such coal-forming environments as the Everglades, the huge swamplands of southern Florida, U.S.A. Under the proper conditions, these materials could eventually develop into peat and then, over hundreds of thousands of years, into the various kinds of coal.

Coal beds are also called *coal seams* or *coal veins*. Present-day seams range in thickness from less than 2.5 centimetres to 120 metres or more. The thickest seams are subbituminous coals and lignites. Many coal deposits consist of two or more seams separated by layers of rocks. These formations were produced by new coal-forming swamps developing over buried ones. Each new swamp became buried and developed into a separate seam of coal.

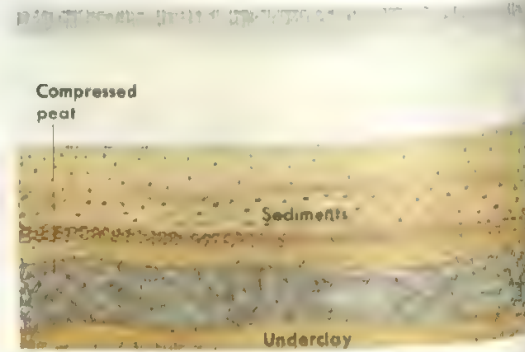
Some coal beds lie nearly parallel to the earth's surface. Other beds have been tilted by earth movements and lie at an angle to the surface. Most of the deepest beds consist of anthracites or bituminous coals. In many cases, earth movements have uplifted deep anthracite and bituminous beds to a position nearer the surface. This accounts for coal seams in hills and mountains.

The development of coal

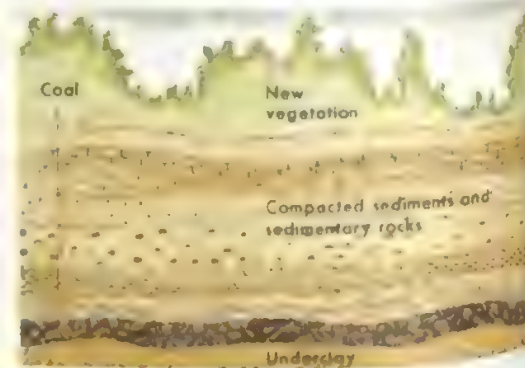
The formation of coal involved three main steps. (1) The remains of dead plants turned into a substance called *peat*. (2) The peat became buried. (3) The buried peat was subjected to great pressure. After thousands or millions of years under pressure, the peat turned into coal. Each of these steps is illustrated below.



A thick layer of peat developed as plant matter accumulated and hardened on the floor of a swamp. The matter built up as plants that grew in the swamp died and sank to the bottom. Peat-forming swamps once covered much of the earth.



Deposits of loose mineral matter, called *sediments*, completely covered the peat bed. As these sediments continued to pile up over the bed, they compressed the peat.



Pressure on the peat increased as the sediments became more compact and heavier. Some sediments hardened into rock. The increasing pressure turned the peat into coal.

The way in which coal is used depends on its chemical composition and moisture content. Coal is often referred to as a mineral. But unlike a true mineral, it has no fixed chemical formula. All coal consists of certain solids and moisture. The solids are composed chiefly of the elements carbon, hydrogen, nitrogen, oxygen, and sulphur. However, coal varies widely in the amount of each element it contains as well as in its moisture content. In fact, no two deposits of coal are exactly alike in their makeup.

Coal is usually classified according to how much carbon it contains. Coal can thus be grouped into four main classes, or *ranks*. These four ranks are: (1) anthracites; (2) bituminous coals; (3) subbituminous coals; and (4) lignites, or brown coals. The carbon content of the coals decreases down through the different ranks. The highest-ranking anthracites contain about 98 per cent carbon. The lowest-ranking lignites have a carbon content of only about 30 per cent. The amount of moisture in the coals can be as low as less than 1 per cent, in anthracites and bituminous coal, and as high as 45 per cent, in lignites. High-moisture subbituminous and lignite coals have a lower *heating value* than do anthracites and bituminous coals. Heating value refers to the amount of heat that is produced by a given amount of coal when it is burned.

Bituminous coals are by far the most plentiful. They are also the most widely used of the major ranks of coals. They have a slightly higher heating value than do anthracites and are the only coals suited to making coke. Anthracites are slow to ignite. They also burn too slowly to be suitable for industrial purposes such as the gener-

ation of electricity. Anthracites are also the least plentiful of the four ranks of coals.

Coal as a fuel

Coal is a useful fuel because it is abundant and has a relatively high heating value. However, coal has certain impurities that limit its usefulness as a fuel. These impurities include sulphur and various minerals. As coal is burned, most of the sulphur combines with oxygen and forms a poisonous gas called *sulphur dioxide*. Most of the minerals turn into ash. The coal industry refers to ash-producing substances in coal as ash even before the coal is burned.

Coal known as *low-sulphur coal* can be burned in fairly large quantities without adding harmful amounts of sulphur dioxide to the air. *Medium-* and *high-sulphur coals* can cause serious air pollution if they are burned in large quantities without proper safeguards. The difficulty and the high cost of developing safeguards have greatly restricted the use of coal as a fuel. Some of the ash produced by burning powdered coal may also escape into the air. Like sulphur dioxide, such *fly ash* can contribute to air pollution. However, devices have been developed to trap fly ash in smokestacks and so prevent it from polluting the air.

Coal is used as a fuel chiefly in the production of electricity.

Electric power production. The great majority of electric power stations are *steam-turbine plants*. All nuclear power stations and almost all those fuelled by coal, gas, or oil are steam-turbine plants. They use high-pressure steam to generate electricity. The steam spins



A coking plant heats coal in airtight ovens to make *coke*, an essential raw material in the manufacture of steel. This batch of red-hot coke is being released from an oven into a railway truck. The truck will carry it to another part of the plant to cool.



A conveyor system at a power station removes coal from a stockpile and carries it to the power station's boilers. Coal-burning power stations produce most of the electricity used in the world.

the wheels of turbines, which drive the generators that produce electricity. Steam-turbine plants differ mainly in how they create the heat to make steam. Nuclear plants create the heat by splitting uranium atoms. The other plants burn coal, gas, or fuel oil. See **Electric generator**; **Electric power**; **Turbine**.

Bituminous coals have long been the preferred coals for electric power production because they are the most plentiful coals and have the highest heating value. Subbituminous coals and lignites have the lowest heating value.

Other uses of coal as a fuel. In parts of Asia and Europe, coal is widely used for heating homes and other buildings. In the United States, natural gas and fuel oil have almost entirely replaced coal as a heating fuel. However, the rising cost of oil and natural gas has led some factories and other commercial buildings to switch back to coal. Anthracites are the cleanest-burning coals, and so they are the preferred coals for heating homes. However, anthracites are also the most expensive coals. For this reason, bituminous coals are often preferred to anthracites for heating factories and other commercial buildings. Subbituminous coals and lignites have such a low heating value that they must be burned in large amounts in order to heat effectively. As a result, they are seldom used for heating.

In the past, coal was also used to provide heat for the manufacture of a wide variety of products, from glass to canned foods. Since the early 1900's, manufacturers have come to prefer the use of natural gas in making most of these products. Coal is used mainly by the cement and paper industries. However, some industries have switched back to coal to avoid paying higher prices for natural gas.

Coal as a raw material

Many substances made from coal serve as raw materials in manufacturing. Coke is the most widely used of these substances. Coke is made by heating bituminous coal to about 1100° C in an airtight oven. The lack of oxygen prevents the coal from burning. The heat changes some of the solids in the coal into gases. The remaining solid matter is coke—a hard, foamlike mass of nearly pure carbon. It takes about 1.5 metric tons of bituminous coal to produce 1 metric ton of coke. For an illustration of the coke-making process, see **Coke**.

The coal used to make coke is called **coking coal**. To be suitable for coking, the coal must have various characteristics, such as a low sulphur content and a specified amount of ash. Only certain types of bituminous coals have all the necessary characteristics.

Most coking plants are a part of steel mills. The mills burn coke with iron ore and limestone to change the ore into the pig iron required to make steel. It takes about 410 kilograms of coke to produce 0.9 metric ton of pig iron. For a description of the role of coke in the iron-making process, see the *World Book* article **Iron and steel** (Raw materials; illustration: How a blast furnace operates).

The coke-making process is called **carbonization**. Some of the gases produced during carbonization turn into liquid ammonia and coal tar as they cool. Through

further processing, some of the remaining gases change into light oil. Manufacturers use the ammonia, coal tar, and light oil to make such products as drugs, dyes, and fertilizers. Coal tar is also used for roofing and for road surfacing. Some of the gas produced during carbonization does not become liquid. This **coal gas**, or **coke oven gas**, burns like natural gas. But coal gas has a lower heating value and, unlike natural gas, gives off large amounts of soot as it burns. Coal gas is used chiefly at the plants where it is produced. Coal gas provides heat for the coke-making and steel-making processes.

Gas can be produced from coal directly, without carbonization, by various methods. Such methods are known as **gasification**. The simplest gasification method involves burning coal in the presence of forced air or steam. The resulting gas, like coke oven gas, has a low heating value and produces soot. It is used chiefly in some manufacturing processes. Coal can be used to make high-energy gas and such high-energy liquid fuels as petrol and fuel oil. But the present methods of producing these fuels from coal are costly and complex. Researchers are working to develop cheaper and simpler methods. The section **Coal industry** later in this article discusses this research.



Coal is found on every continent. Deposits occur as far north as the Arctic and as far south as Antarctica. Some coal deposits occur off ocean coastlines. However, such deep underwater deposits have little commercial value at this time because they are particularly difficult to mine.

Coal deposits that can be mined profitably are called *coal reserves*. In most cases, a coal seam must be at least 60 centimetres thick for mining engineers to class it as a reserve. Some long-range estimates of coal reserves include beds 30 to 60 centimetres thick. But such thin beds would probably be mined only after more productive deposits were exhausted. Most estimates of coal reserves include only tested deposits. The coal reserves may be larger or smaller than the estimates.

To estimate coal reserves, mining engineers drill into

the ground in suspected coal-bearing areas. A drill brings up samples of the rock formations in the order in which they occur. The depth and thickness of a coal seam can thus be estimated. By taking a number of such samples, engineers can estimate the extent of a particular deposit. A large area of tested reserves is called a *coal field*.

World coal reserves. No reliable estimates exist for the total amount of coal that lies beneath the earth's surface. The world's *proved recoverable reserves* of coal total over 1 trillion metric tons. This figure represents the amount of coal that can be profitably recovered from known deposits with current technology. Most of the proved recoverable reserves are in Australia, China, Germany, India, Indonesia, Poland, Russia, South Africa, and the United States.

How coal is mined

Coal mines can be divided into two main groups: (1) surface mines and (2) underground mines. In most cases, surface mining involves stripping away the soil and rock that lie over a coal deposit. This material is

known as *overburden*. After the overburden has been removed, the coal can easily be dug up and hauled away. Underground mining involves digging tunnels into a coal deposit.



Surface mining is usually limited to coal deposits within 30 to 60 metres of the earth's surface. The more overburden that must be removed, the more difficult and costly surface mining becomes. Most coal deposits deeper than 60 metres are mined underground.

Surface mining

Nearly all surface mining is *strip mining*—that is, mining by first stripping away the overburden. Many coal seams are exposed on the sides of hills or mountains. In some cases, these seams are mined from the surface without removing any overburden. Miners use machines called *augers* to dig out the coal. This method of surface mining is known as *auger mining*.

Strip mining depends on powerful machines that dig up the overburden and then dump it out of the line of work. The dug-up overburden is called *spoil*. In time, a strip mine and its spoil may cover an enormous area of land. The digging up of vast areas of land has caused serious environmental problems in the past. As a result, some governments now require all new strip-mined land to be *reclaimed*—that is, returned as closely as possible to its original condition. Strip mining thus involves methods of (1) mining the coal and (2) reclaiming the land.

Mining the coal. Most strip mines follow the same basic steps to produce coal. First, bulldozers or loaders clear and level the vegetation and soil above the mining area. Many small holes are then drilled through the rocky overburden to the coal bed. Each hole is loaded with explosives. The explosives are set off, shattering the rock in the overburden. Giant power shovels or other earthmoving machines then clear away the broken rock. Some of these earthmovers are as tall as a 20-storey building and can remove more than 3,200 metric tons of overburden per hour. After a fairly large area of coal is exposed, explosives may be used again. Coal-digging machines then scoop up the coal and load it into trucks. The trucks carry the coal from the mine.

Although most strip mines follow the same basic steps, strip-mining methods vary according to whether the land is flat or hilly. Strip mining can thus be classed as either (1) area mining or (2) contour mining. Area mining is practised where the land is relatively level. Contour mining is practised in hilly or mountainous country. It involves mining on the *contour*—that is, around slopes.

In area mining, an earthmover digs up all the broken overburden from a long, narrow strip of land along the edge of the coal field. The resulting deep ditch is referred to as a *cut*. As the earthmover digs the cut, it piles the spoil along the side of the cut that is away from the mining area. The piled spoil forms a ridge called a *spoil bank*. After the cut is completed, the coal is dug, loaded into trucks, and hauled away. The earthmover then digs an identical cut alongside the first one. It piles the spoil from this cut into the first cut. This process is repeated over and over across the width of the coal field until all of the coal has been mined. The spoil banks form a series of long, parallel ridges on the land that can later be levelled.

Area mining is impractical where coal seams are em-

bedded in hills. If a seam lies near the top of a hill, an earthmover may simply remove the hilltop and so expose the coal. If a seam lies near the base of a hill, it must be mined on the contour.

In contour mining, an earthmover removes the shattered overburden immediately above the point where a seam *outcrops* (is exposed) all around a hill. The resulting cut forms a wide ledge on the hillside. The spoils may be stored temporarily on the hillside or used to fill in the cuts. After the exposed coal has been mined and hauled away, the earthmover may advance up the slope and dig another cut immediately above the first one. However, the depth of the overburden increases sharply with the rise of the slope. After the first or second cut, the overburden may be too great for machines to remove profitably. But if the seam is thick enough, engineers may dig an underground mine to remove the rest of the coal.

Reclaiming the land. The chief environmental problems that strip mining can cause result from burying fertile soil under piles of rock. The rocks tend to give off acids when exposed to moisture. Rainwater runs down the bare slopes, carrying acids and mud with it. The runoff from the slopes may wash away fertile soil in surrounding areas and pollute streams and rivers with acids and mud.



Strip mining depends on giant earthmoving machines like the one at the top of this picture. The earthmover strips away the soil and rock that lie over a coal deposit. A coal-digging machine, centre, then scoops up the coal and loads it into a truck.

The first step in reclaiming strip-mined land is to reduce the steep slopes formed by the spoil. The spoil banks created by area mining can be levelled by bulldozing. The spoil from contour mining can be used to fill in the cuts in the hillsides. As much topsoil as possible should then be returned and the area replanted.

Auger mining. A coal auger is a machine shaped like an enormous corkscrew. It bores into the side of a coal outcrop on a slope and twists out the coal in chunks. Contour mines often use augers when the overburden in a slope is too great to remove. An auger can penetrate the outcrop and recover coal that could not otherwise be mined. Some augers can bore 60 metres or more into a hillside.

Auger mining chiefly exploits outcrops of high-quality coal that cannot be mined economically by other methods. However, auger mining can recover only a small portion—as little as 15 per cent—of the coal in a seam. The method is best used in combination with contour mining.

Underground mining

Underground mining is more hazardous than surface mining. The miners may be injured or killed by cave-ins, falling rocks, accidental explosions, and poisonous gases. To prevent such disasters, every step in underground coal mining must be designed to safeguard the workers. Some of these safety measures are discussed in this subsection. For a detailed discussion, see the section *The coal industry*.

Underground mining generally requires more human labour than surface mining. But even so, underground mines are highly mechanized. Machines do all the digging, loading, and hauling in modern mines.

In most cases, miners begin an underground mine by digging two access passages from the surface to the coal bed. One passage will serve as an entrance and exit for the miners and their equipment. The other passage

will be used to haul out the coal. Both passages will also serve to circulate air in and out of the mine. As the mining progresses, the workers dig tunnels from the access passages into the coal seam.

Underground mines can be divided into three main groups according to the angle at which the access passages are dug into the ground. The three groups are (1) shaft mines, (2) slope mines, and (3) drift mines. Some mines have two or all three types of passages.

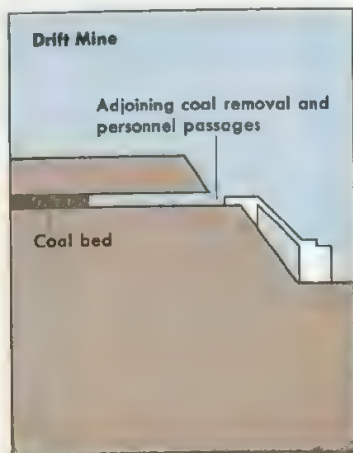
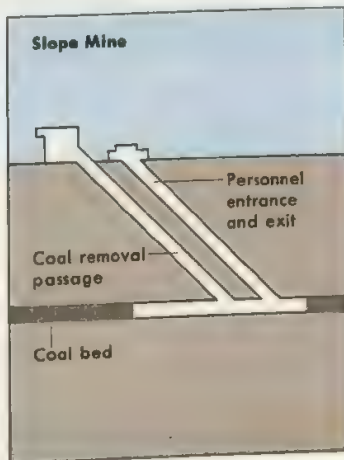
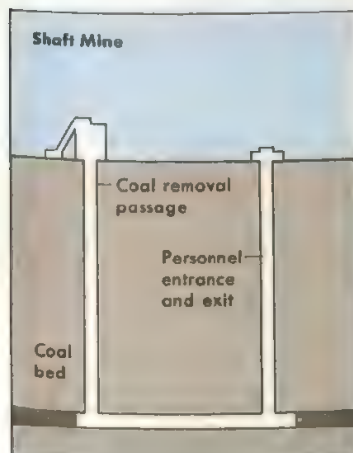
In a shaft mine, the access passages run straight down from the surface to the coal seam. The entrance and exit shaft must have a hoist. Most extremely deep mines are shaft mines. In a slope mine, the access passages are dug on a slant. They may follow a slanting seam or slant down through a hillside to reach a seam under the hill. Drift mines are used to mine seams of coal that are embedded in hills or mountains. The access passages are dug into a seam where it outcrops on a slope. They thus parallel the ground.

Two main systems of underground mining are used: (1) the room-and-pillar system and (2) the longwall system. Each system has its own set of mining techniques. Either system may be used in a shaft, slope, or drift mine. The room-and-pillar system is by far the more common system of underground mining in the United States. The longwall system is more widely used elsewhere, especially in European countries.

The room-and-pillar system involves leaving pillars of coal standing in a mine to support the overburden. Miners may begin a room-and-pillar mine by digging three or more long, parallel tunnels into the coal seam from the access passages. These tunnels are called *main entries*. In most cases, the walls of coal separating the main entries are 12 to 24 metres wide. Cuts are made through each wall every 12 to 24 metres. The cuts thus form square or rectangular pillars of coal that measure 12 to 24 metres on each side. The coal dug in building the entries is hauled to the surface.

Kinds of underground mines

There are three main kinds of underground mines: (1) shaft mines, (2) slope mines, and (3) drift mines. In a shaft mine, the entrance and exit passages are vertical. In a slope mine, they are dug on a slant. In a drift mine, the passages are dug into the side of a coal bed exposed on a slope.

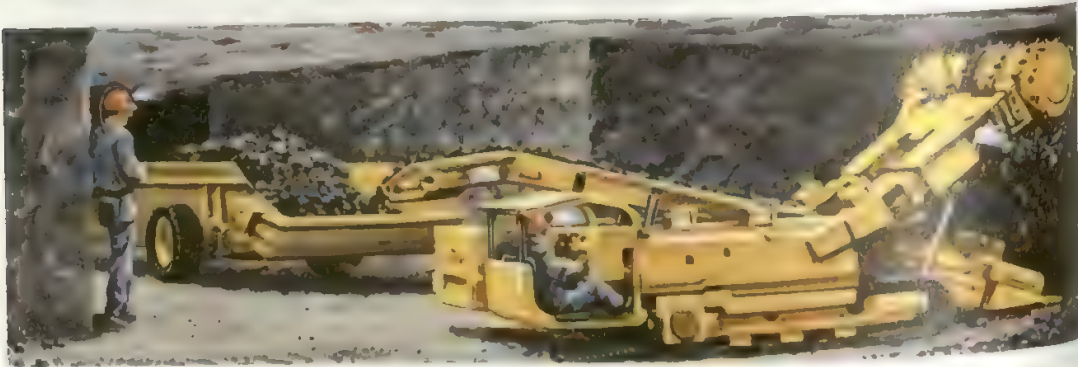


Types of underground-mining equipment

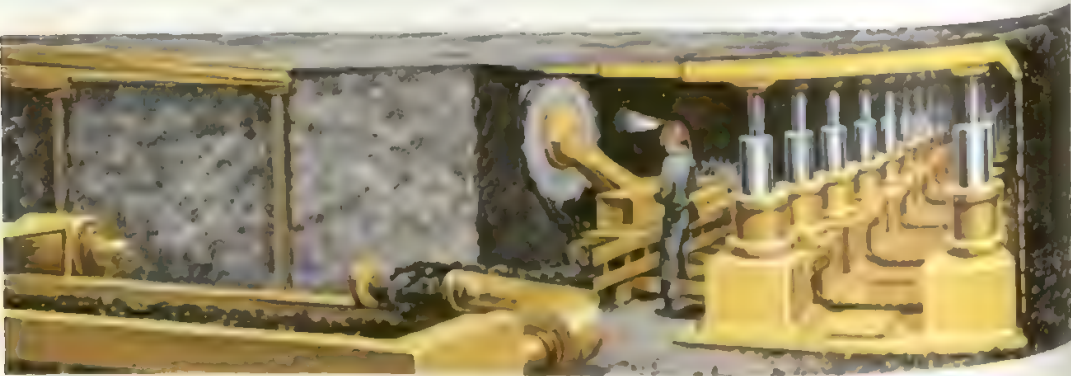
The type of equipment that an underground mine requires depends on the method of mining it uses. Mechanized mines use three main methods: (1) the conventional method, (2) continuous mining, and (3) longwall mining. Each of the three methods calls for a different type of equipment.



Conventional-mining equipment. The conventional method of mining involves a series of steps, three of which require special machinery. First, a cutting machine, *left*, cuts a deep slit along the base of the coal face (coal exposed on the surface of a mine wall). Another machine, *centre*, drills holes into the face. Miners load the holes with explosives and then set the explosives off. The undercutting along the bottom of the face causes the shattered coal to fall to the floor. A loading machine, *right*, gathers the coal onto a conveyor belt.



Continuous-mining equipment eliminates the series of steps in mining a face. A continuous mining machine, *right*, gouges out the coal and loads it onto a shuttle car in one operation.



Longwall-mining equipment. Longwall mining differs from the other methods of underground mining in its system of roof support. The other methods are used only in room and pillar mines, where pillars of coal are left to support the mine roof. In the longwall method, movable steel props support the roof over one long coal face. The miners move a cutting machine back and forth across the face, shearing off coal. The coal falls onto a conveyor. As the miners advance the cutter into the bed, the roof supports are moved forward. The roof behind the miners is allowed to fall.

The pillars help support the overburden in the main entries. But in addition, the tunnel roofs must be bolted to hold them in place. To bolt the roof, the miners first drill holes 0.9 to 1.8 metres or more into the roof. They then insert a long metal bolt into each hole and fasten the free end of each bolt to the roof. The bolts bind together the separate layers of rock just above the roof and so help prevent them from falling. The miners must also bolt the roof in all other parts of the mine as they are developed.

A railway track or a conveyor belt is built in one of the main entries to carry the coal to the access passages. A mine railway may also provide transportation for the miners along the main entries. At least two main entries serve chiefly to circulate air through the mine. An underground mine may also need such facilities as water drainage ditches, gas drainage pipes, compressed air pipes, and electric power cables. These facilities are built into the main entries and later extended to other parts of the mine.

After the main entries have been constructed, the miners dig sets of *subentries* at right angles from the main entries into the coal seam. Each set of subentries consists of three or more parallel tunnels, which serve the same purposes as the main entries. Cuts are made through the walls separating these tunnels, forming pillars like those between the main entries. At various points along each set of subentries, the miners dig *room entries* at right angles into the seam. They then begin to dig *rooms* into the seam from the room entries.

As the miners enlarge a room, they leave pillars of coal to support the overburden. A room is mined only a certain distance into the seam. When this distance is reached, the miners may remove the pillars. The room roof collapses as the pillars are removed, and so they must be removed in *retreat*—that is, from the back of the room toward the front. The miners' exit from the room thus remains open as the roof falls. Pillars are also sometimes removed from entries. Like room pillars, they must be removed in retreat to protect the miners.

All room-and-pillar mining involves leaving pillars in place. Room-and-pillar mines differ, however, in their mining methods. Mechanized room-and-pillar mines use two main methods: (1) the conventional mechanized method and (2) continuous mining.

The *conventional mechanized method* was more widely practised during the 1930's and 1940's than it is today. During the 1930's, it largely replaced the earlier method of digging coal by hand. Since about 1950, continuous mining has increasingly replaced the conventional method.

The conventional method involves five main steps. (1) A machine that resembles a chain saw cuts a long, deep slit, usually along the base of the coal face. (2) Another machine drills a number of holes into the face. (3) Each hole is loaded with explosives. The explosives are set off, shattering the coal. The undercutting along the bottom of the face causes the broken coal to fall to the floor. (4) A machine loads the coal onto shuttle cars, scoops, or a conveyor. (5) Miners bolt the roof that has been exposed by the blast.

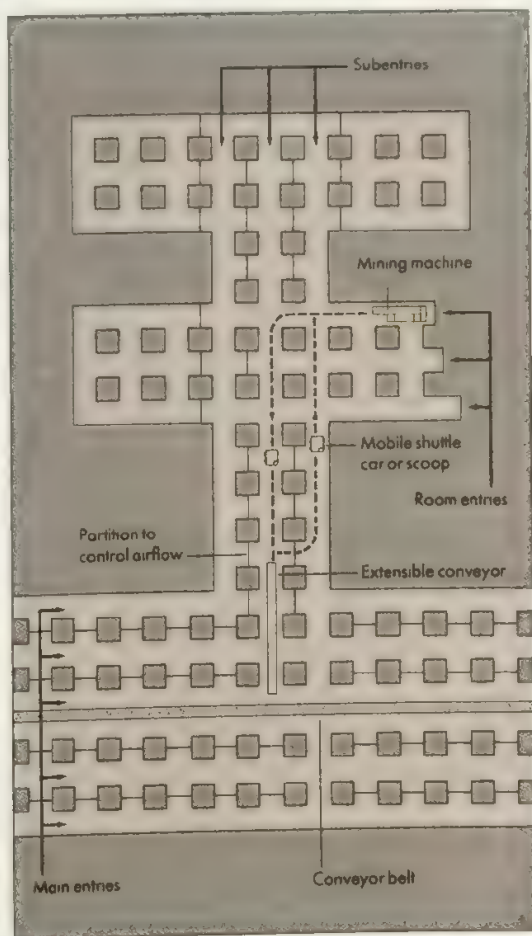
A separate crew of miners carries out each of the five

steps. After a crew has completed its job on a particular face, the next crew moves in. The miners can thus work five faces of coal at a time. But there are frequent pauses in production as the crews finish work on one face and move on to the next.

Continuous mining now predominates in the underground coal mines of some nations. The method uses machines called *continuous miners*. A continuous miner gouges the coal from the *coal face*—that is, the coal exposed on the surface of a wall. One worker operating a continuous miner can produce about 1.8 metric tons of

The room-and-pillar system

Many underground mines use the *room-and-pillar system* of mining. First, the miners dig tunnels called *main entries* into the coal bed from the entrance and exit passages. They then dig sets of *subentries* into the bed from the main entries and sets of *room entries* into the bed from the subentries. Pillars of coal are left standing in all the entries to support the mine roof. As the room entries are extended, they create large *panels* of coal. The miners eventually dig *rooms* into the panels to recover as much coal as possible from the bed. This floor plan of a room-and-pillar mine shows how the entries are developed.





A worker operating a continuous miner can produce about 1.8 metric tons of coal per hour. These machines can dig and load coal faster than the coal can be hauled out of a mine.

coal per hour. The machine automatically loads the coal onto shuttle cars or a conveyor belt, which carries it to the railway or conveyor in the main entries.

A continuous miner can usually dig and load coal much faster than the coal can be hauled out of a mine. The machine can work faster than the haulage, roof-bolting, ventilation, construction, and drainage systems can be completed. As a result, a continuous miner must frequently be stopped to allow the other mine systems to catch up.

The longwall system of underground mining involves digging main tunnels or entries like those in a room-and-pillar mine. However, the coal is mined from one long face, called a *longwall*, rather than from many short faces in a number of rooms.

A longwall face is about 90 to 210 metres long. The miners move a cutting machine back and forth across the face, ploughing or shearing off the coal. The coal falls onto a conveyor belt. Movable steel props support the roof over the immediate work area. As the miners work the machine farther into the seam, the roof sup-

porters are advanced. The roof behind the miners is allowed to fall. After a face has been dug out 1,200 to 1,800 metres into the seam, a new face is developed and mined. This process is repeated until as much coal as possible has been removed from the seam.

The longwall system originated in Europe where underground mines tend to be deep. The pressure of the overburden becomes intense in an extremely deep mine. Longwall mining relieves the pressure by allowing the roof to cave in throughout most of a mine. In a European longwall mine, the roof remains in place only over the main entries, over the longwall face, and over two tunnels leading to the face. The mines can thus recover up to 90 per cent of the coal in a seam.

A variation of the longwall method is called *shortwall mining*. A shortwall face is only about 45 to 60 metres long, and it is mined with continuous mining machines rather than with longwall equipment. This system, which was developed in Australia, is suited to coal seams whose structure prevents them from being divided into long faces.

Cleaning and shipping coal

Much coal is shipped to buyers exactly as it comes from the mine without any processing. In the coal industry, such coal is called *run-of-mine coal*. It ranges in size from fine particles to large chunks.

The two largest users of coal, the electric power industry and the coking industry, have definite quality requirements for the coal they buy. Much run-of-mine coal does not meet these requirements because it contains unacceptable amounts of impurities. Coal producers must *clean* this coal by removing the impurities before they can sell it.

Cleaning coal. Coal producers clean coal in specially designed *preparation plants*. Most large coal mines have a preparation plant on the mine property. The plants use a variety of machines and other equipment to

remove the impurities from coal before they sell it.

Ash and sulphur are the chief impurities in coal. The ash consists chiefly of mineral compounds of aluminum, calcium, iron, and silicon. Some of the sulphur in coal is also in the form of minerals, especially *pyrite*, a compound of iron and sulphur. The rest is *organic sulphur*, which is closely combined with the carbon in coal. Run-of-mine coal may also contain pieces of rock or clay. These materials must be removed in addition to the other impurities.

Preparation plants rely on the principle of *specific gravity* to remove the impurities from run-of-mine coal. According to this principle, if two solid substances are placed in a solution, the heavier substance will settle to the bottom first. Most of the mineral impurities found in

coal are heavier than pure coal. As a result, these impurities can be separated from run-of-mine coal that is placed in a solution. The entire coal-cleaning process involves three main steps: (1) sorting, (2) washing, and (3) dewatering.

Sorting. Large pieces of pure coal may settle to the bottom of a solution faster than small pieces that have many impurities. Therefore, the pieces must first be sorted according to size. In many preparation plants, a screening device sorts the coal into three sizes—coarse, medium, and fine. Large chunks are crushed. The crushed pieces are then sorted into the three main batches according to size.

Washing. The typical preparation plant uses water as the solution for separating the impurities from coal. Each batch of sorted coal is piped into a separate washing device, where it is mixed with water. The devices separate the impurities by means of specific gravity. The heaviest pieces—those containing the largest amounts of impurities—drop into a refuse bin. Washing removes much of the ash from coal. But the organic sulphur is so closely bound to the carbon that only small amounts can be removed.

How impurities are removed from coal

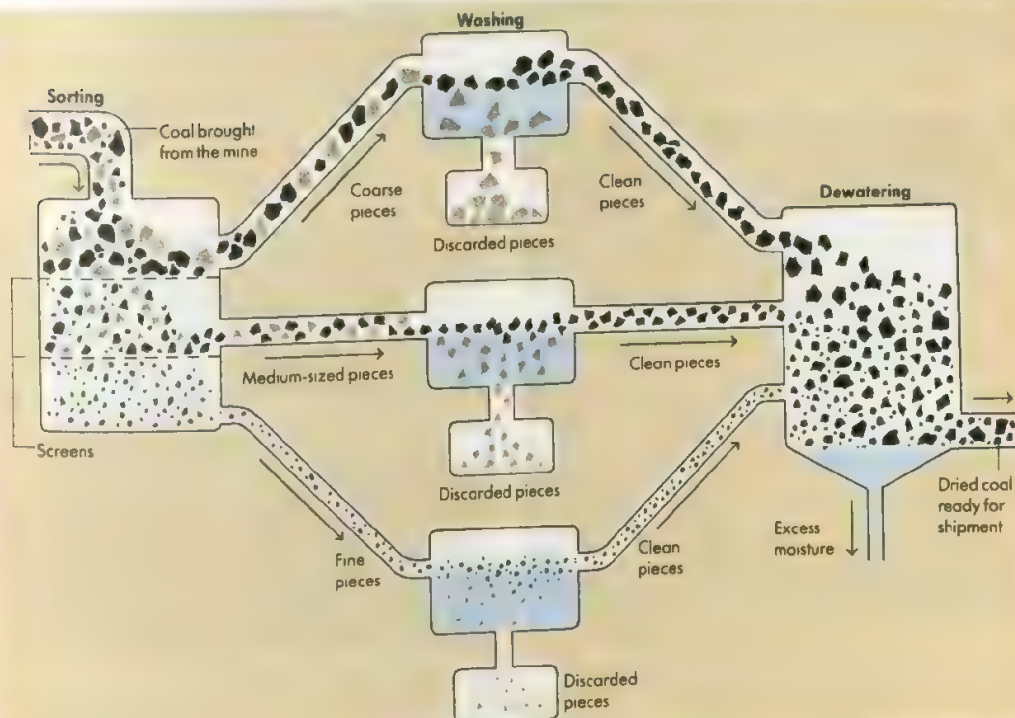
Mining organizations remove mineral impurities from coal by a process called *cleaning*. The process involves three main steps. (1) A screening device sorts the coal into batches of three sizes. (2) Each batch is piped into a separate washing device and mixed with water. The impurities in coal are heavier than pure coal. As a result, the first pieces of coal to settle to the bottom of each solution are those that contain the most impurities. Any loose pieces of rock or clay mixed in with the coal also sink to the bottom. All the waste pieces are discarded. (3) The clean pieces are dewatered with vibrators, spinning devices, or hot-air blowers. The coal is then ready for shipment to buyers.

Dewatering. Washing leaves the coal dripping wet. If this moisture is not removed, the heating value of the coal will be greatly reduced. Preparation plants use vibrators, spinning devices called *centrifuges*, and hot-air blowers, to dewater coal after it is washed.

In most cases, the separate batches of coal are mixed again before or after dewatering. The resulting mixture of various sizes of coal is shipped chiefly to power stations and coking plants. All coking plants and many power stations grind coal to a powder before they use it. They therefore accept shipments of mixed sizes. Some coal users require coal of a uniform size. Preparation plants that supply these users leave the cleaned coal in batches graded according to the size of the pieces.

Shipping coal. Most coal shipments within a country are carried by rail, barge, or truck. In many cases, a particular shipment must travel by two or all three of these means to reach the buyer. Huge cargo ships transport coal across oceans, between coastal ports, and on large inland waterways.

Barges provide the cheapest way of shipping coal within some countries. But they can operate only between river or coastal ports. Trucks are the least costly



means of moving small shipments of coal short distances by land. Much coal, however, must be shipped long distances over land to reach buyers. Railways offer the most economical means of making such shipments.

Coal can even flow through pipes from mines to power plants. A 439-kilometre underground pipeline carries coal from a mine in Arizona to a power plant in Nevada, U.S.A. The coal is crushed and mixed with water to form a *slurry* (soupy substance) that can be pumped through the pipeline. The coal and power industries are considering building other such pipelines in the United States. In some cases, however, pipelines are more costly and less efficient than the traditional methods of shipping coal.

Coal industry

In most countries, the central government owns all or nearly all the coal mines. The major exceptions include Australia, Canada, Germany, South Africa, and the United States. In the United Kingdom, the government has initiated a programme of privatizing its coal industry. In countries where all or nearly all the coal mines are privately owned, however, the central government still regulates certain aspects of the coal industry.

The United States and Australia are the world's leading coal exporters. About one-quarter of all coal exports come from mines in the United States. Other leading exporters include Canada, Poland, Russia, and South Africa. Japan purchases approximately 30 per cent of the world's coal exports—far more than any other country.

Mineworkers. Large coal-mining organizations have a full-time staff of professional workers, including engineers, lawyers, and business experts. They also employ

In the past, nearly all coal shipments consisted of anthracite, bituminous coal, or subbituminous coal. It costs as much to ship a given amount of lignite as it costs to ship the same amount of a higher-ranking coal. But lignite has the lowest heating value of the four ranks. It therefore could not formerly compete with the higher-ranking coals in distant markets. Lignite was used chiefly by power plants built in lignite fields. Conveyor belts or small railways carried the coal from the mines to the plants. However, the growing need for low-sulphur coal has increased the demand for lignite. As a result, it has become economic for some lignite to be shipped by rail from mines to power plants hundreds of kilometres away.

electricians, mechanics, and construction workers. Skilled miners, however, provide the labour on which the industry depends. Underground mining requires more miners than does surface mining.

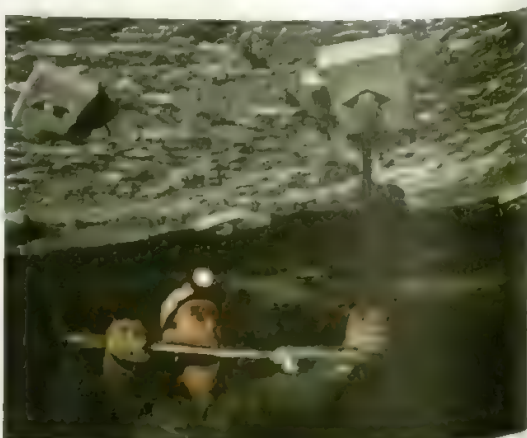
Mechanization has helped miners become more productive. In 1950, each coal miner in the United States produced, on average, about 6.5 metric tons of coal daily. Today, the production rate averages about 27 metric tons per miner per day. On average, a strip miner produces approximately more than twice as much coal as does an underground miner.

Increased mechanization has also made miners' jobs more specialized. Most miners operate a certain type of machine, such as a continuous miner or a power shovel. Such tasks need considerable experience and training.

In the 1800's, coal mining was poorly paid and unsafe, and coal miners lived and worked under miserable conditions. Many banded together in trade unions that called strikes in protest. Since the early 1900's, mine-workers' lives have greatly improved in the industrially developed countries.



Coal miners provide the labour on which the coal industry depends. These miners have just finished their day's work in an underground mine. They are boarding the train that will carry them to the mine exit.



Bolting the roof is an essential safety practice in an underground mine. Roof bolts are long metal rods that are inserted into the mine roof. After a bolt is fastened to the roof, above it helps prevent the rock layers immediately overhead from falling.

How strip-mined land is reclaimed

In some countries, the law requires mine owners to reclaim all the land they use for strip mining. The first step is to level the piles of dug-up soil and rock, *left*. The area may then be reseeded, *centre*. The project is finally completed when the new vegetation is fully grown, *right*.



Mine safety. In the early days of underground coal mining, the work was extremely dangerous. Accidents killed or disabled thousands of miners every year. Then governments began introducing regulations that set minimum health and safety standards for employers and employees alike. Death rates fell dramatically, in some cases by as much as 85 per cent.

Mine safety involves four main types of problems. They are (1) accidents involving machinery, (2) roof and wall failures, (3) accumulations of gases, and (4) concentrations of coal dust.

Accidents involving machinery kill or injure more coal miners in a typical year than does any other kind of mining accident. Most strip mine accidents involve machinery. The machines in underground mines must often operate in cramped, dimly lit spaces. The miners must therefore be doubly alert to prevent accidents.

Roof and wall failures can be prevented in many cases by effecting a scientific roof support plan. Mining engineers make a roof support plan after studying all the rock formations surrounding the coal bed. The plan deals with such matters as the number of pillars that must be left standing, entry widths, mine geometry, and the number of roof bolts that must be used.

Accumulations of gases. Certain gases that occur in underground coal mines can become a serious hazard if they accumulate. *Methane* and *carbon monoxide* are especially dangerous. Methane is an explosive gas that occurs naturally in coal seams. It is harmless in small amounts. However, a mixture of 5 to 15 per cent methane in the air can cause a violent explosion. Carbon monoxide is a poisonous gas produced by the combustion of such fuels as coal and oil. Blasting in an underground mine may produce dangerous levels of carbon monoxide if the mine is improperly ventilated.

The air vents in a mine normally prevent harmful gases from accumulating. A powerful fan at the surface circulates fresh air through the mine. The circulating air forces polluted air to the surface. As an added precau-

tion against methane, many underground mines may have automatic methane detectors. A mine may shut down temporarily if a detector shows a methane accumulation of more than 2 per cent.

Concentrations of coal dust. Anyone who breathes large amounts of coal dust over a period of years may develop a disease called *pneumoconiosis* or *black lung* (see **Black lung**). The disease interferes with a person's breathing and may eventually cause death. Thousands of coal miners have been victims of the disease. High concentrations of coal dust are also explosive. A mixture of coal dust and methane is especially dangerous.

Leading coal-producing countries



Figures are for 1991, prior to the breakup of the Soviet Union and Czechoslovakia. Source: U.S. Energy Information Administration

Proper ventilation removes much of the coal dust from the air in a mine. However, mines must also use other dust control measures. In this process, the miners spray powdered limestone on all exposed surfaces in the mine entries. The limestone dilutes and coats the coal dust and so lessens the chance of an explosion. Mines use water sprays to hold down the dust along a face that is being mined.

Coal research has become increasingly important. The goals of most coal research are (1) to find ways to burn more coal without increasing air pollution and (2) to develop economical methods of converting coal into liquid fuels and synthetic natural gas.

Pollution control. Industrial nations have begun introducing legislation to reduce sulphur dioxide emission from coal-burning power stations.

Cleaning removes some of the sulphur from coal. But it does not remove enough from high-sulphur and some medium-sulphur coals to meet air quality standards. Sulphur dioxide can be controlled to some extent by devices called *scrubbers*. A scrubber absorbs sulphur dioxide fumes as they pass through a plant's smokestacks.

Researchers are now working to develop new processes for using coal to produce power. These processes will make coal use more efficient and safer for the environment. They include *fluidized-bed combustion*. In this process, crushed coal is burned in a bed of limestone. The limestone captures sulphur from the coal and so prevents sulphur dioxide from forming. The heat from the burning coal boils water that is circulated through the bed in metal coils. The boiling water produces steam, which may be used to produce electricity.

Coal conversion. To turn coal into a high-energy fuel, the hydrogen content of the coal must be increased. Bituminous coals have the highest hydrogen content of

the four ranks of coal. On average, they consist of about 5 per cent hydrogen. The hydrogen must be increased to about 12 per cent to produce a high-energy liquid fuel and to about 25 per cent to produce synthetic natural gas.

The process of converting coal into a liquid fuel is called coal *hydrogenation* or *liquefaction*. Various methods of coal hydrogenation have been developed. In the typical method, a mixture of pulverized coal and oil is treated with hydrogen gas at high temperatures and under great pressure. The hydrogen gradually combines with the carbon molecules, forming a liquid fuel. This process can produce such high-energy fuels as petrol and fuel oil if sufficient hydrogen is added.

Coal can easily be turned into low-energy gas by the carbonization and gasification methods described in the section *The uses of coal*. Low-energy gas can also be produced from unmined coal. This process, called *underground gasification*, involves digging two widely spaced wells from ground level to the base of a coal seam. The coal at the bottom of one well is ignited. Air is blown down the second well. The air seeps through pores in the seam, and the fire moves toward it. After a passage has been burned between the two wells, the air current forces the gases up the first well to the surface. Compared with natural gas, low-energy gas made from coal has limited uses. Low-energy gas must be enriched with hydrogen for its heating value to equal that of natural gas.

The present methods of obtaining high-energy fuels from coal cost too much for commercial use. Hydrogen is expensive to produce. In addition, most fuels made from coal contain unacceptable amounts of sulphur and ash. Researchers are trying to develop cheaper methods of coal conversion.

History of the use of coal

No one knows where or when people discovered that coal can be burned to provide heat. The discovery may have been made independently in various parts of the world during prehistoric times. The Chinese were the first people to develop a coal industry. By the A.D. 300's, they were mining coal from surface deposits and using it to heat buildings and smelt metals. Coal had become the leading fuel in China by the 1000's.

Commercial coal mining developed more slowly in Europe. During the 1200's, a number of commercial mines were started in England and in what is now Belgium. The coal was dug from open pits and used mainly for smelting and forging metals. But most Europeans regarded coal as a dirty fuel and objected to its use.

Wood, and charcoal made from wood, were the preferred fuels in Europe until the 1600's. During the 1600's, a severe shortage of wood occurred in western Europe. Many western European countries, especially England, then sharply increased their coal output to relieve the fuel shortage.

Developments in England. During the 1500's, English factories burned huge quantities of charcoal in making such products as bricks, glass, salt, and soap. By the

early 1600's, wood had become so scarce in England that most factories had to switch to coal. By the late 1600's, England produced about 80 per cent of the world's total coal output. It remained the leading coal producer for the next 200 years.

Charcoal had also been widely used in England as a fuel for drying malt, the chief ingredient in beer. Brewers tried using coal for this process. But the gases it produced were absorbed by the malt and so spoiled the flavour of the beer. The brewers found, however, that the undesirable gases could be eliminated if they preheated the coal in an airtight oven. They thus developed the process for making coke. About 1710, an English ironmaker named Abraham Darby succeeded in using coke to smelt iron. Coke then gradually replaced charcoal as the preferred fuel for ironmaking.

The spread of the new ironmaking process became part of a much larger development in England—the Industrial Revolution. The revolution consisted chiefly of a huge increase in factory production. The increase was made possible by the development of the steam engine in England during the 1700's. Steam engines provided the power to run factory machinery. But they required a



Before mining became mechanized and child labour was abolished, boys and mules provided much of the labour. The photograph above shows a mine of the late 1800's in Pennsylvania, U.S.A.

plentiful supply of energy. Coal was the only fuel available to meet this need.

Developments worldwide. During the 1800's, the Industrial Revolution spread from England to other parts of the world. It succeeded chiefly in countries that had an abundance of coal. Coal thus played a key role in the growth of industry throughout this period in Europe and North America.

Coal became essential not only to manufacturing but also to transportation. Steamships and steam locomotives were becoming the chief means of transportation, and they required huge amounts of coal to fire their boilers. As industry and transportation grew in the United States, so did the production and use of coal. In the early 1800's, there were few coal mines in the United States. However, by the late 1800's, the United States had replaced England as the world's leading coal producing country.

The United States led in coal production until the mid-1900's. Its demand for coal then declined as the use of petroleum and natural gas increased. The Soviet Union surpassed the United States in coal production from the late 1950's to the late 1970's. During the 1980's, China usually ranked first, and the United States usually ranked second.

Recent developments. The growing scarcity of petroleum and natural gas has led to a sharp rise in the demand for coal. As a result, world coal production increased greatly in the 1970's and the 1980's. The increased output of coal was used mainly to produce electricity.

Today, electricity can be produced more cheaply from coal than from either natural gas or fuel oil. However, the cost of coal-generated electricity will almost certainly increase for several reasons. To meet environmental standards, power plants that burn medium- or

high-sulphur coal must invest in costly sulphur dioxide scrubbers. To obtain low-sulphur coal, power plants must pay to have it shipped from the major producing areas. As coal deposits near the surface are used up, mines must be dug deeper and deeper. The high operating costs of extremely deep mines will add to the price of coal.

Power producers, like other businesses, pass their added costs on to their customers. Thus, even though coal is plentiful, the energy it produces will become increasingly expensive.

Study aids

Related articles in *World Book* include

Basic coal products

Ammonia
Coal tar
Coke

Coke oven gas
Gas (fuel)

Other related articles

Black lung
Child labour
Damp
Diamond
Energy supply
Heating (Coal)

Hydrogenation
Industrial Revolution
Iron and steel
Mining
Peat
Safety lamp

Outline

- I. How coal was formed
- II. Uses of coal
 - A. Coal as a fuel
 - B. Coal as a raw material
- III. Where coal is found
 - A. World coal reserves
- IV. How coal is mined
 - A. Surface mining
 - B. Underground mining
- V. Cleaning and shipping coal
 - A. Cleaning coal
 - B. Shipping coal
- VI. Coal industry
 - A. Mineworkers
 - B. Mine safety
 - C. Coal research
- VII. History of the use of coal
 - A. Developments in England
 - B. Developments worldwide
 - C. Recent developments

Questions

- How was coal formed?
What is the main use of coal?
Why are coal miners more productive today than they were in the past?
How is coal usually classified? What are the four main classes of coal?
What are *preparation plants*? Why are they needed?
Why did many countries in western Europe sharply increase their coal output during the 1600's?
What is *strip mining*? What environmental problems can it cause? How can these problems be prevented?
Why has coal mining become a less dangerous occupation than it was in the past?
Why have more and more power plants switched from bituminous coal to subbituminous coal or lignite?
Which two countries are the world's leading exporters of coal?
Which country imports more coal than any other country?

Coal-dust explosion. See Coal (Mine safety).

Coal gas. See Coke oven gas.

Coal oil. See Paraffin.

Coal tar is a thick, black, sticky liquid. It is obtained as a by-product in the manufacture of coke and coke oven gas from soft coal. Coal tar is recovered by partially *condensing* (changing to liquid) the hot vapours from a coke oven or a coal gas producer. Further condensation of the vapours produces light oils, such as *benzene* and *toluene*. Benzene is used as a solvent and in the production of perfumes and some petrols, and toluene is used in the manufacture of dyes, paints, explosives, and anti-septics.

Tar acids, such as *carbolic acid*, and tar bases, such as *aniline*, are other coal tar products. Carbolic acid and aniline are used to make dyes. *Creosote* and *pitch* are heavy liquid coal tar products. Creosote preserves wood, and pitch is used in the manufacture of roofing materials and paint. Perfumes, dyes, and drugs are made from coal tar products. Sir William H. Perkin, an English chemist, pioneered work in coal tar chemistry by making mauve, the first synthetic dye. *Petrochemicals* (chemicals made from petroleum) are increasingly supplementing coal tar chemicals for use in industry.

Related articles in World Book include:

Aniline	Dye
Benzene	Naphtha
Coal (Coal as a raw material)	Perfume
Coke	Pitch
Coke oven gas	Tar
Creosote	Toluene
Distillation (Destructive distillation)	

Coalescence theory. See Rain (Formation of rain; diagram: The coalescence theory).

Coalition is a combination of political interest groups working toward a mutual goal. Coalitions often form in countries with parliamentary forms of government because these systems have a number of political parties. A single party may be unable to win a majority in the parliament, causing various parties to form coalitions that have a majority of seats.

The United Kingdom had coalition governments during both World Wars, and following the Great Depression of the 1930's, in order to ensure national unity. In some countries, no political party can command a peacetime majority in the parliament, and all governments are coalitions. This can result in frequent changes of government. For example, Italy has had more than 45 changes of Cabinet since World War II. Since 1977, Israel has been ruled either by the Likud bloc—a coalition of small parties—or by a coalition of Likud with the rival Labour party.

See also **Political party** (Multiparty systems).

Coanda, Henri Marie (1885-1972), a civil aeronautics engineer and inventor, designed an aeroplane based on a jet-propulsion system. He crashed in it on take-off near Paris in 1912. Coanda also developed a disc-shaped craft, based on an aerodynamic principle called the Coanda effect.

Coanda was born in Bucharest, Romania. He studied at various schools, including the École Supérieure de l'Aéronautique. Coanda's other inventions include a device that is able to convert salt water to fresh water by using the energy of the sun.

Coast Ranges are a series of mountains that form the western coast of North America for about 4,020 kilometres. The ranges extend from Kodiak Island, Alaska, through Canada to southern California. Twelve separate mountain ranges make up the Coast Ranges region. The Kodiak, Kenai, Chugach, and St. Elias ranges, and the Alexander Archipelago, a group of islands formed by the tops of sunken mountains, are in Alaska. The Queen Charlotte Islands and the Vancouver Range are in British Columbia. The Olympic Mountains rise in Washington, and the Oregon Coast Range extends from southern Washington to central Oregon. The Klamath Mountains rise in southern Oregon and northern California. The California Coast Range is in central California, and the Los Angeles Ranges rise along the coast of southern California.

The northern coast is sunk in great bays and straits from Shelikof Strait to Puget Sound. The southern coastline is high and regular, broken only by a few harbours.

See also **United States** (The Pacific Ranges and Lowlands); **Olympic Mountains**.

Coat of arms. See **Heraldry**.

Coatbridge is a large industrial town in Strathclyde Region, Scotland, situated about 14 kilometres east of Glasgow. It is part of the local government district of Monklands. Industries in Coatbridge include steel milling, engineering, food processing, and clothes manufacturing.

See also **Monklands**.

Coates, Eric (1886-1957), was an English composer, conductor, and viola player. He is best known as a composer of light music. Among his most popular light works are the *Merrymakers Overture*, *The London Suite*, and *March, The Dam Busters*. He also wrote ballets, including *The Jester at the Wedding*. Coates was born at Hucknall, in Nottinghamshire, England.

Coati, also called *coatimundi*, is a member of the raccoon family. It has a long, flexible snout and often carries its long, ringed tail straight up. Coatis live in wooded areas of the Americas, from Arizona in the United States southward to northern Argentina. They measure from 40 to 65 centimetres long, not counting the tail, and weigh from 4.5 to 7 kilograms. Coatis of the



The coati is related to the raccoon. It has a long flexible snout and a long ringed tail. The animal uses its claws to dig in the ground, and it will eat almost any food it can easily find.

dry hills of Arizona have sandy blond fur. Chocolate-brown coatis live in the rain forest of Panama. South American coatis are reddish-brown.

Coatis eat almost anything they can easily find, including insects, land crabs, snails, spiders, and a variety of fruits. They also eat birds' eggs, lizards, and mice.

Coatis move about mostly in the daytime and are at home both on the ground and in trees. They are curious, intelligent animals and continually sniff the air and dig into the ground with their claws as they wander through the woods. Females and young coatis travel in bands of 6 to 20 animals, but adult males live alone. The word *coatimundi* is an American Indian term meaning "lone coati," and it actually refers only to the males.

Each year, one male joins each band for the mating season, which lasts about a month. About 10 or 11 weeks after mating, the pregnant females leave the group. They build tree nests of sticks and leaves and give birth to three or four young. About six weeks later, the mothers and their young rejoin the bands. See also **Animal** (picture: Animals of the tropical forests).

Scientific classification. Coatis form the genera *Nasua* and *Nasuella* in the raccoon family, Procyonidae. One species is *Nasua narica*.

Coatimundi. See **Coati**.

Coatsworth, Elizabeth (1893-1986), was an American author best known for her children's books. Much of her work deals with rural New England, U.S.A., but she also wrote fantasies and stories with settings in early American history and the Far East. She won the 1931 Newbery Medal for *The Cat Who Went to Heaven* (1930), which resembles a Japanese Buddhist folk tale.

Coatsworth's other children's books include *Away Goes Sally* (1934), *Sword of the Wilderness* (1936), *Here I Stay* (1938), *Door to the North* (1950), *First Adventure* (1950), *The Enchanted* (1951), *Silky* (1953), *The White Room* (1958), *The Hand of Apollo* (1965), *They Walk in the Night* (1969), *Grandmother Cat and the Hermit* (1970), and *Under the Green Willow* (1971). Coatsworth also wrote novels, poetry, and stories for adults. She was born in Buffalo, New York.

Coaxial cable is an electrical conductor consisting of a central, insulated conducting wire that is surrounded by a flexible, tube-shaped conducting shielding. This type of cable is termed coaxial because both the central conductor and outside shielding have the same axis. Coaxial cables can conduct high-frequency signals much better than ordinary twisted wires. Therefore they are widely used to connect antennas to television receivers. Because of their capacity to transmit high-frequency signals, a single coaxial cable can carry a large number of communication channels simultaneously over long distances. Each communication channel occupies a different narrow frequency band in the high-frequency signal transmitted through the cable. Coaxial cables are used in long-distance telephone networks for transmitting large numbers—up to several thousands—of conversations simultaneously. They are also used to distribute several television programmes simultaneously in cable television systems and to transmit digital signals at high speed between computers and computer terminals.

Because the shielding protects the central conductor from external electromagnetic interference when connected to the earth terminal of electronic appliances, con-



A typical coaxial cable contains 22 tube-enclosed communications wires and many other wires for maintenance and control. The cable is about 8 centimetres in diameter.

axial cables are used in audio equipment. Microphones or gramophone turntables are connected to the input of an amplifier via coaxial cables. Using ordinary wire would result in the picking up of interference produced by the electric mains, audible as a loud hum. For the same reason, coaxial cables are used to connect sensitive detectors, such as photomultiplier tubes, to scientific instruments.

See also **Cable**; **Telephone**; **Television**.

Cobalt is a silver-white metallic chemical element used chiefly in alloys. Cobalt has many of the properties of iron and nickel. All three metals are hard and magnetic, and they react with common acids to produce hydrogen.

Cobalt has the chemical symbol Co. Its atomic number is 27, and its atomic weight is 58.9332. Cobalt has a density of 8.9 grams per cubic centimetre. It melts at 1495° C and boils at 2870° C. Cobalt was discovered in 1737 by a Swedish chemist named Georg Brandt.

Sources. The total amount of cobalt in the earth's crust is relatively small. Cobalt occurs in compounds with arsenic, oxygen, or sulphur; and in ores of nickel and other metals. Cobalt is also found in meteorites. Canada has large deposits of an arsenide ore that contains cobalt, nickel, and iron. These deposits lie in Ontario. Cobalt ore also occurs in Azerbaijan, Finland, Kazakhstan, Russia, Zaire, and Zambia. The United States has only small deposits of cobalt.

Uses. Most of the cobalt used is in the form of alloys. The rest is in the form of compounds or isotopes.

Cobalt is alloyed with aluminium and nickel, iron, or certain other metals to make magnets. The magnets are used in radios, TV sets, and many other kinds of devices. Cobalt is combined with carbon and tungsten or with chromium, iron, and some other metal to produce exceptionally hard alloys for such implements as drilling bits and cutting tools. Many cobalt alloys can withstand extremely high temperatures. For this reason, they are used in gas turbines, jet engines, and other equipment that operates at high temperatures.

Cobalt compounds include cobalt oxides and cobalt salts. Cobalt oxides are used as pigments to tint enamel, pottery, and glass. The paint industry uses cobalt salts as

drying agents in paints and varnishes. An organic compound of cobalt, vitamin B₁₂, is essential for preventing a disease called *pernicious anaemia* (see **Anaemia**).

The most widely used isotope of cobalt is **cobalt 60**. Scientists prepare this radioactive isotope by bombarding ordinary cobalt, or **cobalt 59**, with neutrons in a nuclear reactor. Cobalt 60 has a *half-life* of about 5 years—that is, about half the atoms in a sample of cobalt 60 decay in 5 years. As cobalt 60 decays, it gives off two kinds of radiation—*beta particles* and *gamma rays*. Cobalt 60 is used to treat cancer because the radiation it emits kills cancer cells. It is also used in diagnosing certain diseases. For example, doctors test for pernicious anaemia by feeding a patient vitamin B₁₂ containing some cobalt 60. A radiation detector then measures the amount of cobalt 60—and the vitamin—in the patient's urine. Doctors thus determine if the body is absorbing the vitamin normally.

Cobalt 60. See **Cobalt**.

Cobb, John Rhodes (1899-1952), a British driver, once held both the world land speed record and the world water speed record. In September 1947, Cobb set a land speed record of

394.2 miles (624.4 kilometres) an hour in his Railton Special at Bonneville Salt Flats, Utah, in the United States. This speed is the average of two runs over a measured mile (1,609 metres). On the second run, Cobb achieved a speed of 403.1 miles (648.7 kilometres) an hour. He became the first person to exceed 400 miles (643.7 kilometres) an hour on land.

Cobb was born in Esher, in Surrey, England. He was educated at Eton College and at Trinity Hall, Cambridge. He was killed while attempting to break the world water speed record on Loch Ness in Scotland. Cobb's boat, *Crusader*, overturned when it was travelling at a speed of 206.9 miles (333 kilometres) an hour.



John Cobb



Ty Cobb was one of the first players elected to the U.S. National Baseball Hall of Fame.

Cobb, Ty (1886-1961), was one of the greatest and most exciting players in American baseball history. He ranks as the all-time leading hitter in American major league baseball with a .367 lifetime batting average. Cobb's career total of 4,191 hits also was a major league record until Pete Rose broke it in 1985. Cobb won 12 American League batting titles, including 9 in a row from 1907 to 1915. He also was an expert base runner, stealing 892 bases during his 24-year career.

Tyrus Raymond Cobb was born near Homer, in Banks County, Georgia. He was nicknamed "The Georgia Peach." Cobb, an outfielder, began his major league career with the Detroit Tigers in 1905 and played with the team until 1926. He also managed the Tigers from 1921 to 1926. He spent 1927 and 1928, the final years of his career, playing for the Philadelphia Athletics. Cobb was unpopular with opponents because of his frequent rough play. In 1936, he became one of the first five players elected to the National Baseball Hall of Fame.

See also **Baseball**.



John Cobb was once the fastest person on land and on water. He was killed when his boat *Crusader*, left, overturned on Loch Ness in Scotland.



Cobb and Co.'s coaches operated passenger and mail services in Australia from 1853 to 1924. The light coaches were drawn by teams of from 4 to 12 horses.

Cobb and Co. organized the first reliable transport system in Australasia. Its horse-drawn coach services operated for 70 years in Australia and New Zealand.

In 1853, Freeman Cobb, with three other American businessmen, established Cobb and Co. to provide organised public transport in Victoria, Australia. The company began its first service between Melbourne and Port Melbourne in 1853. In the same year, it began another run between Melbourne and Bendigo. Soon the company operated services to all the major goldfields in Victoria. It acquired a reputation for reliability, and the government granted it a contract to deliver mail. In 1858, Cobb sold his interests in the company and returned to the United States. The company changed hands several times, but retained its original name. It expanded its services in Australia, and in New Zealand, it began operating mail coaches to the goldfields of Central Otago.

In the early 1860s, railways began to provide alternative transport facilities. In 1862, Cobb and Co. moved its headquarters from Bendigo to Bathurst, in New South Wales, to serve the goldfields there. In 1865, it extended its services into Queensland, running coach services between Brisbane and Ipswich. As the railways expanded their services, the coaches went farther into the outback to carry passengers to the railheads. By 1890, the company controlled about 6,437 kilometres of passenger routes in Queensland alone.

In the early 1900s, the coaches were gradually replaced by other forms of transport. The last Cobb and Co. coach ran between Yuleba and Surat, in Queensland, in 1924. It is now in the Queensland Museum in Brisbane.

Cobbett, William (1763?-1835), a British journalist and politician, became noted for his book *Rural Rides* (1830), in which he made strong comments on the state of agriculture and politics in Britain. This work was a reprinting from the *Weekly Political Register*, a political paper he began in 1802. In this paper, Cobbett at first supported the Tories, but later championed radicalism. Cobbett's books include *A Bone to Gnaw for the Democrats* (1795), *English Grammar* (1818), *History of the Protestant Reformation* (1824-1827), and *Advice to Young Men* (1839).

Cobbett was born at Farnham, in Surrey, England. He

made several visits to the United States, where, under the pen-name Peter Porcupine, he wrote a number of pro-British pamphlets.

Cobden, Richard (1804-1865) a British politician and economist, advocated free trade, particularly in corn. In 1838, he was the leading member of the Anti-Corn Law League. The Corn Laws controlled the price and import and export of grain. In 1841, he became Member of Parliament for Stockport, near Manchester. He supported a policy of nonintervention abroad and the minimum of state interference in home affairs. He declined government office and, with reform politician John Bright's support, worked to abolish the Corn Laws. By the time his campaign succeeded, in 1846, Cobden's textiles business had suffered greatly from neglect. He was saved from ruin only by a large public subscription.

Cobden opposed Britain's entry into the Crimean War (1853-1856), and this stand contributed to his defeat in 1857. Cobden was reelected in 1859. His last important achievement was the arrangement of a trade pact with France in 1860. Both countries agreed to reduce tariffs. Cobden always championed the middle classes and once described trade unionism as "an unjustified use of monopoly," though he later modified this view. Cobden opposed government interference in factories, except when it concerned child labour.

Cobden was born at Heyshott, in West Sussex, England. In 1828, with two friends, he started a textiles business in Manchester. He studied economics and travelled widely while he was developing his commercial interests.

See also **Corn Laws; Peel, Sir Robert.**

Cobh (pop. 6,372) is a port and holiday resort in County Cork in the Republic of Ireland. It lies on the southern shore of Great Island in Cork Harbour. The town forms a half-circle facing the harbour. The land rises steeply from the harbour, and the town has developed both along the beach and on the hill. Cobh is 24 kilometres from Cork by road, and 13 kilometres by water.

The natural harbour known as the *Cove of Cork* was first used extensively in the 1700s. The port town grew up because ships could load and unload easily there without sailing to Cork.



Cobh is a holiday resort town facing Cork Harbour in the Republic of Ireland. St. Colman's Cathedral rises near the shore.

When Queen Victoria landed at the port in 1849, the British renamed it *Queenstown* in her honour. The Irish went back to the original name *Cobh*, the Gaelic spelling of *cove*, in 1922. Many victims of the torpedoed passenger liner *Lusitania* are buried at Cobh (see *Lusitania*). **Cobham, Sir Alan John** (1894-1973), a British aviator, pioneered refuelling in the air and introduced this system to the United States Air Force and Navy, and the British Royal Air Force, in 1951.

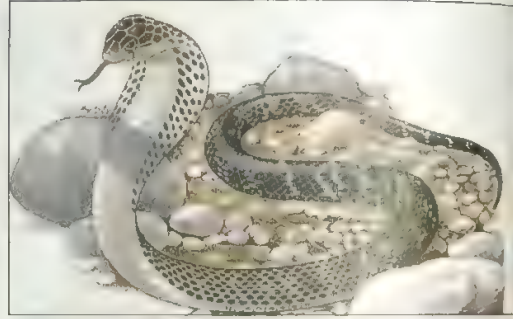
Cobham was born in London. He served with the Royal Flying Corps in World War I. After the war, he entered civil aviation. He took part in inaugural airline flights in Europe, northern Africa, and southwestern Asia, and long-distance return flights from England to Burma, South Africa, and Australia, in 1925 and 1926. He also wrote several books.



Sir Alan Cobham

Cobra is any one of a group of poisonous "hooded" snakes. Cobras are highly active, and, when excited, flatten the neck by moving the ribs. This movement gives the appearance of a hood. In most snakes, the neck ribs are shorter than those farther back. But in cobras with large hoods, the neck ribs are the longest. These ribs are almost straight instead of curved like those of the body.

Cobras use their deadly poison in two ways. Some types bite their victims with poison fangs in the front of



An Indian cobra may grow to nearly 2 metres in length. The snake's colour ranges from yellowish to dark brown. It has a mark like a pair of spectacles on the back of its hood.

the upper jaw. Others also squirt the poison at the eyes of the victim. In these kinds, the fangs are shaped so that the poison is sent forward when the cobra tilts back its head. This "spitting" is most highly developed in two African cobras and one East Indian cobra. The venom spat out harms humans only when it gets in their eyes. It causes severe irritation and even blindness if not washed out immediately. The bite may cause death within a few hours.

A full-grown Indian cobra is nearly 2 metres long, and measures about 15 centimetres around its body. Its colour ranges from yellowish to dark brown. On the back of its hood it has a mark like a pair of spectacles. It is sometimes called "spectacled cobra."

Most cobras eat many kinds of animals, such as frogs, fishes, birds, and various small mammals. A dangerous enemy of the cobra is the tiny mongoose. This extremely swift animal attacks and usually kills the snake. See **Mongoose**.

Cobras live in Africa, Southern Asia, and the East Indies, including the Philippine Islands. The *king cobra* of southeastern Asia is by far the largest of the group, and the longest poisonous snake known. It reaches a length of 5.5 metres. It has a narrow hood. Most king cobras retreat from people and will attack only when they are surprised while guarding their eggs. King cobras prey mainly on other snakes.

Cobras are found in various types of country, and may even enter houses. Cobras are not so dangerous as generally believed, because of the way they attack. Unlike rattlesnakes and other vipers, cobras prepare for battle by lifting up the front of the body without curving it like an S. Thus, an opponent can well judge how far a forward jab will reach. A person can easily knock down a rearing cobra by swinging a level stick. The cobra's fangs do not deliver the poison nearly so well as the viper's. The cobra's are shorter, and cannot be folded back. But cobras often chew an object after they have seized it. This habit helps them to inject the poison into their victims.

The jugglers and snake charmers of India usually use the cobra because of its unusual hood and its habit of rearing upright. They pretend to charm snakes with music, but the snakes can hear only a limited range of sounds and cannot hear the music. When they are being "charmed," they are only holding themselves on guard.

They would do the same thing without the music.

Scientific classification. Cobras belong to the terrestrial poisonous snake family, Elapidae. The Indian cobra is *Naja naja*. The king cobra is *N. hannah*.

See also **Asp; Snake (picture); Snake charming; Snakebite.**

Coca is one of a group of South American shrubs or small trees. Coca trees grow from 1 to 2 metres tall. The Huanuco coca is a greenish-brown plant with shiny, thick stems. The leaves are about 2.5 to 7.5 centimetres long with smooth edges. The Truxillo coca is pale green and has smaller leaves that smell like tea leaves. The leaves of both plants taste bitter and produce a numbness of the tongue and lips when chewed.

The dried leaves of coca plants contain several drugs used in medicine, including cocaine, tropacocaine, and hygrine. South American Indians chew coca leaves with lime. The drugs in the leaves keep them from feeling tired or hungry but do not nourish the body.

Scientific classification. Coca plants belong to the coca family, Erythroxylaceae. They are classified as *Erythroxylon coca*.

Cocaine is a powerful drug made from leaves of the coca shrub of South America. Many countries forbid the importation, manufacture, and use of cocaine for non-medical purposes. But many people obtain it illegally and use it for its pleasurable effects. Such use can be dangerous, with users developing a compulsive desire for and dependence on the drug.

Medical use of cocaine is extremely limited. A few surgeons prescribe cocaine as a local *anaesthetic* (pain-killer) during certain kinds of surgery. They prefer cocaine because, in addition to blocking pain sensations, it causes small arteries to tighten, thus reducing bleeding during surgery.

Illegal use of cocaine has increased rapidly since the 1970's. Most users of the drug seek the feeling of intense pleasure, known as a *high*, that occurs for a short period after taking cocaine. Many people are introduced to the drug in social settings and start using it because their friends do.

Illegal cocaine is a white powder that consists of cocaine hydrochloride—the active ingredient—mixed with other compounds. It is most commonly taken by "snorting" a small amount into the nose, where it is absorbed through the nasal lining. Some cocaine users inject the drug into a vein to produce more rapid and powerful effects. Just as rapid and even stronger effects are obtained by smoking a type of cocaine called *free base*. Cocaine is also smoked in a potent pellet form called *crack*. The injecting and the smoking of cocaine account for a large number of drug-related medical emergencies.

Physical and psychological effects. Cocaine is a *stimulant*—that is, it increases the activity of the nervous system. Cocaine causes sudden increases in heart rate and blood pressure. It also produces a feeling of *euphoria* (a sense of well-being). People feel alert and powerful, and their thinking seems better and clearer than usual. Occasionally, strong feelings of anxiety and fear occur instead of the expected high.

Cocaine use can be habit-forming. When the drug's effects wear off, usually after 20 to 40 minutes, people often feel depressed, and take another dose in an effort to regain the euphoria. Habitual users may eventually

come to feel that nothing is enjoyable without cocaine. Some users come to crave the drug constantly.

The long-term use of cocaine may cause some people to suffer depression or *psychosis* (severe mental breakdown), which makes them unrealistically suspicious or fearful. These symptoms may continue for weeks or months, even after a person has stopped using the drug.

History. The Andean Indians of South America have chewed coca leaves for thousands of years. This practice does not produce a high—but it does reduce fatigue and hunger, and it helps the Indians work more effectively in the high altitude of the mountains.

A German scientist discovered how to extract cocaine from the coca leaves in the mid-1800's. Many doctors at first considered it a miracle drug. During the late 1800's, doctors prescribed cocaine for all sorts of physical and mental ailments, including exhaustion, depression, alcoholism, and morphine addiction. Many of the patent medicines of the day contained cocaine, so the drug became widely used.

Unfortunately, overuse caused many people to become dependent on the drug, and complications surfaced. Enthusiasm over the drug gave way to disappointment. By the mid-1900's, medical and nonmedical use of cocaine had become far less common. During the 1970's, however, claims of the drug's harmlessness and exciting effects triggered renewed popularity for its illegal use. As use of the drug increased, the number of cocaine-related problems also increased. In the 1980's, concern over cocaine use helped trigger widespread international antidrug movements.

Coccyx. See **Skeleton** (The axial skeleton).

Cochise (1800?-1874) was an American Indian chief who fought white settlers living in what are now Arizona and New Mexico. He led the Chiricahua band of the Apache Indians. The name *Cochise* means *firewood* in Apache.

During the 1850's, the Chiricahua were friendly with the whites. The peaceful relations ended in 1861, when Cochise was falsely accused of kidnapping a settler's child. The United States Army captured Cochise and several members of his tribe and ordered him to return the child. Cochise escaped, but the troops seized six Chiricahua and threatened to kill them if the child was not returned. Cochise then took several whites as hostages and offered to exchange them for the captured Apaches. The Army refused this offer, and so Cochise hanged his hostages. He then went to war against the settlers.

In 1867, a frontiersman named Thomas J. Jeffords went to Cochise's camp and persuaded him to let mail carriers pass through the Indian land. In 1869, Jeffords led General Oliver O. Howard to Cochise to discuss peace. Cochise agreed to stop fighting and moved his band to a reservation in Arizona.

Cochlea. See **Ear** (The inner ear; diagram: The inner ear).

Cochran, Sir Charles Blake (1872-1951), was a British stage producer who became famous for his spectacular shows. He made his name in 1911 with a production of *The Miracle*, which had a chorus of 500 and an orchestra of 200.

Cochran staged many musical revues, and he had great success with Noel Coward's musical comedies

This Year of Grace (1928), *Bitter Sweet* (1929), and *Cavalcade* (1931). His longest-running production was Vivian Ellis's *Bless the Bride* (1947), which lasted for 886 performances.

Cochran was born at Lindfield, in West Sussex, England. He began his career as an actor, but his success began when he became the manager of a wrestler. At various times, he was also a theatrical agent and a promoter of boxing and wrestling bouts.

Cochran, Jacqueline (1912-1980), was an American businesswoman and pioneer aeroplane pilot. She started flying in 1932, and was the only woman in the McRobertson London-Melbourne Race in 1934. Cochran also became the first woman to compete in the Bendix Trophy Race, which she won in 1938. In World War II, she organized and commanded the Women Airforce Service Pilots (WASPs). She was the first civilian woman to receive the Distinguished Service Medal. Cochran owned a cosmetics firm from 1935 to 1963. In 1971, she was elected to the U.S. National Aviation Hall of Fame. She was born in Pensacola, Florida.



Jacqueline Cochran

Cock of the rock is a handsome South American bird with a rich orange plumage and a large crest that hides the bill. The wings and tail are black. The birds live in rocky ravines near mountain streams in the Andes from Colombia to Bolivia and in the mountains of the Guianas and in northern Brazil. At the mating season, the male birds gather together in a cleared spot in the forest where they dance and hop about to attract the females. The bird makes its nest of plant fibres that it glues together with resin and sticks to crevices of rocks. The bird feeds on fruit and lives in the thick undergrowth of the forest.

Scientific classification. The cock of the rock belongs to the cotinga family, Rupicolinae. It is *Rupicola rupicola*.

See also Bird (picture: Birds of Central and South America).



Cocks of the rock live in South America. The female, left, has dull colours. The male, right, has bright orange feathers.

Cockatiel, also spelled *cockateel*, is a grey bird related to the cockatoo. It lives throughout Australia, except in coastal areas. The cockatiel is about 32 centimetres long and has a crown of feathers on its head and a long, tapered tail. Male cockatiels have bright orange and yellow patches on their faces. Females have duller face patches.

The cockatiel lives in open country and is often found in trees bordering rivers or streams. Its favourite foods are seeds, grain, fruit, and berries, so farmers consider it a nuisance. The cockatiel is a popular pet because it is fairly quiet and affectionate, and it may learn to "speak" a few words.

Scientific classification. The cockatiel belongs to the family Cacatuidae. It is *Nymphicus hollandicus*.



Male cockatiel

Cockatoo is the name of several large birds that look like parrots. Cockatoos live in Australia, Indonesia, and neighbouring islands. Unlike parrots, cockatoos have a crest of feathers that can be raised and lowered. A cockatoo's colouring may be combinations of white, black, red, rose, or grey. The common white cockatoo has a yellow or rose crest. The cockatoo has a powerful, curved bill and a thick tongue. It has strong feet with which it climbs about the branches of trees.

Cockatoos feed on seeds, nuts, and fruits. These birds are serious pests in regions where there are many or-



Cockatoos resemble parrots. The two species shown above are the black cockatoo, left, and the white, or sulphur-crested, cockatoo, right.

chards. They are often seen in large flocks that fly swiftly. Cockatoos nest in holes in trees and lay white eggs. The large *white cockatoo*, also called the *sulphur-crested cockatoo*, is a common cage bird and a good talker.

Scientific classification. Cockatoos belong to the family *Cacatuidae*. The black cockatoo is *Probosciger aterrimus*. The white, or sulphur-crested, cockatoo is *Cacatua galerita*.

See also **Parrot**.

Cockcroft, Sir John Douglas (1897-1967), a British nuclear physicist, won the 1951 Nobel Prize for physics with Ernest T. S. Walton for being the first to disintegrate atomic nuclei with artificially accelerated particles. In 1932, Cockcroft and Walton bombarded lithium nuclei with high-speed protons, producing two helium nuclei in the reaction. During World War II (1939-1945), Cockcroft directed an atomic research laboratory near Montreal, Canada. After the war, he was placed in charge of the British Atomic Energy Research Establishment. In 1959, he became the first head of Churchill College, Cambridge University. In 1961, he received the Atoms for Peace Award.

Cockcroft was born in Todmorden, northwest of Huddersfield, in West Yorkshire, England.

See also **Particle accelerator**; **Walton, Ernest T. S.**

Cocker spaniel is the name of two similar breeds of dogs, the English cocker spaniel and the American cocker spaniel. The cocker spaniel gets its name because it was originally bred to chase out woodcock for shooting. The English cocker spaniel is the smallest British spaniel, although it is taller than the American cocker spaniel. Most English cockers weigh from 12.5 to 14.5 kilograms, and stand 38 to 41 centimetres high at the shoulder. American cockers weigh about the same but average around 38 centimetres high. All cockers have soft, thick coats with *feathers* (long hairs) on the ears, chest, and legs. The American breed has a slightly longer coat. Cocker spaniels come in several different colours. Some dogs are solid coloured, and others are *parti-coloured* (a mixture of colours). Colours include black, reddish brown, buff, and white. See also **Dog** (picture, Sporting dogs).

Cockerell, Sir Christopher (1910-), a British electronics engineer, was a pioneer in the development

of the hovercraft. In 1953, he began work on its development privately. In 1958, the National Research Development Corporation, a government agency, gave his project financial support. A new company was formed with Cockerell as director and consultant. In 1959, the prototype hovercraft riding on a cushion of air produced by a jet engine, made its first crossing of the English Channel.

Cockerell was born in Cambridge, England. He was educated at Gresham's School, at Holt, in Norfolk, and at Cambridge University.

See also **Hovercraft**.

Cockfield, Lord (1916-), Francis Arthur Cockfield, a British politician and a Conservative life peer, was a vice president of the European Community Commission from 1985 to 1988. Previously, he had been Britain's secretary of state for trade from 1982 to 1983 and chancellor of the duchy of Lancaster from 1983 to 1984.

Cockfield was born in Dover, Kent, England, and studied law at the London School of Economics. In 1938, he joined the Inland Revenue. Cockfield was chairman of the Price Commission from 1973 to 1977. He was knighted in 1973 and made a baron in 1978.

Cockfighting is a sport in which two *gamecocks* (fighting cockerels) battle each other in a fight to the death. The sport is illegal in many countries. But it is sometimes carried on secretly. Cockfighting ranks as a popular public sport in Spain, Latin America, and parts of eastern Asia.

Gamecocks are specially bred to achieve physical power, speed of movement, courage, and the killer instinct. They usually are brightly coloured and have long spurs on their legs. But breeders generally trim the spurs down, and attach artificial spurs to the gamecocks' legs. The spurs are usually steel or brass. The birds use the weapons to rip and tear at their opponents.

A cockfight takes place in an enclosed pit, usually outdoors. Spectators place bets on their favourite gamecocks. At the start of the fight, handlers hold their birds firmly and allow them to peck at each other. When the birds are angry, they are released and start to fight each other.

Cockfighting probably began in Asia thousands of years ago. The sport came to ancient Greece and Rome by way of India and China. It spread throughout Europe. During the 1600s, the sport became popular in England, where the training and breeding of fighting cocks became an important industry.

Cockle is a sea animal with a tough, protective shell. It is a kind of mollusc. It has a round, grooved shell divided into two equal parts. The cockle moves about by using a long, muscular organ called a *foot*. This foot is strong enough to flip the animal short distances. Cockles live in shallow water along ocean coastlines in many parts of the world. They may be from 1.3 to 20 centimetres in diameter. The largest kinds of cockles are found on the Pacific coast of Central America. Several species of cockle are edible.

Scientific classification. Cockles are in the phylum *Mollusca* and the family *Cardiidae*.

Cocklebur, also known as *clotbur*, is the name of certain species of annual weeds belonging to the daisy family. They all have spiny burs, inside of which are the seeds. There are usually two seeds in each bur. One



The English cocker spaniel is a popular pet.



The cocklebur has spiny, prickly burs.

seed will begin to grow a season before the other seed. Hooked prickles that cover the burs stick to clothing and fur. Cocklebur seedlings are poisonous and can kill pigs and young cattle that graze on them.

Cockleburs are native to North America. They are found in low areas in fields and by roadsides. They are 30 to 90 centimetres tall, and their rough leaves are heartshaped or irregular. Some of the flowers of the cocklebur bear pollen, while others bear seeds. The pollen-bearing ones grow on the upper branches and the seed-bearing ones on the lower. To get rid of cockleburs, the plants must be destroyed before the seeds ripen.

Scientific classification. Cockleburs belong to the daisy family, Compositae (Asteraceae). Cockleburs make up the genus *Xanthium*.

Cockney is a nickname for a citizen of London, particularly one from the East End area. According to tradition, a cockney is anyone born within the sound of the bells of St. Mary-le-Bow Church. *Cockney* also applies to a dialect of English. Speakers change certain vowel sounds; for example, *lady* becomes *lydy* and *road*, *rowd*. They also drop the *h* at the start of words, and may add one in a word starting with a vowel; for example, *ard* for *hard* and *hanswered* for *answered*. The word *cockney* originally meant a misshapen egg. See also **London** (The people).

Cockroach is an insect best known as a household pest. It is closely related to grasshoppers and crickets. Cockroaches have lived on the earth for about 250 million years. There are over 3,500 species found throughout the world. They live in a variety of places, from tropical rain forests to deserts. About 20 species of cockroaches live in human dwellings and are considered pests.

Cockroaches have flat, oval bodies and long legs covered with bristles that serve as a sense of touch. Many cockroaches can fly, and all can run fast. These insects have long *antennae* (feelers) with organs that can detect certain odours.

Cockroaches are scavengers. They eat food and a variety of other substances, including bookbindings, paper, soap, plants, and dead animals. The pest species can live in almost any dwelling as long as the temperature is over 18°C and water is available. They can be a serious problem in flats, hospitals, and restaurants.

Cockroaches are most active at night. If they live in a dirty place, they carry germs.

Most species of cockroaches are found outdoors. In tropical rain forests, cockroaches may live on the forest floor or high in the trees. Some of these tropical cockroaches grow to over 10 centimetres in length, and many are brightly coloured. Cockroaches frequently inhabit caves with bats.



Cockroach

The kinds of cockroaches found in homes include the *common* or *oriental cockroach*, often called a black beetle, the *German cockroach*, the *American cockroach*, the *Australian cockroach*, and the *brown-banded cockroach*. These cockroaches have spread to temperate parts of the world from their original habitats in warm climates, largely carried in trading ships. The German cockroach, which did not originate in Germany, is the most common in North America, while the common cockroach is common in Britain and northern Europe. This cockroach is highly adaptable and resistant to many pesticides.

To keep cockroaches to a minimum in the home, keep the rooms clean and dry. Fix leaky taps, do not overwater house plants, and do not leave out water or dried food for pets. Wash dirty dishes before going to bed at night and store food in sealed containers. Throw away old paper bags and newspapers to avoid creating hiding places for cockroaches. Do not use any pesticide unless it has been approved for use in the home.

Scientific classification. Cockroaches make up the cockroach family Blattidae. The common cockroach is *Blatta orientalis*. The German cockroach is *Blattella germanica*.

Cockscomb is a flower with heads of red and yellow blossoms shaped like a cockerel's comb or like an os-



The cockscomb is a plant with erect, fleshy, clusters of red or yellow flowers. It is often grown in gardens.

trich plume. It is native to tropical America, Asia, and the East Indies, but is now grown in Europe and the United States. It will bloom from midsummer until the autumn frost if planted in light, rich soil that is kept damp.

Scientific classification. Cockscombs belong to the amaranth family, Amaranthaceae. The cockscomb is *Celosia argentea*, variety *cristata*.

Cocktail. See Alcoholic beverage (Liqueurs).

Cocoa. See Chocolate.

Cocoa butter. See Chocolate (Manufacturing).

Coconut. See Coconut palm.

Coconut palm is the tall, graceful tree on which the coconut grows. It probably is native to Southeast Asia and the islands of Melanesia in the Pacific Ocean. But it has been introduced into all the tropical and subtropical parts of the world. It stands from 12 to 30 metres high. Large featherlike leaves spread from the top of its branchless trunk.

The coconut palm is one of the world's most useful trees. People in the tropics can build houses and bridges from its wood. They use whole leaves to make thatched roofs, and strips of leaves to make hats, mats, and baskets. They also make a sweet drink called *toddy* or *tuba* from the sap of the tree's blossoms. They can also use this sap to make sugar, vinegar, and an alcoholic beverage.

The coconut is the fruit of the coconut palm. Clusters of these large round fruit grow among the leaves of the tree. Each coconut has a smooth light-coloured *rind*. Under the rind is a 2.5- to 5-centimetre *husk* of reddish-brown fibres. The husk and rind surround a brown woody shell that has three soft spots called *eyes* at one end. The rind and husk are usually cut away before the coconuts are marketed.

The coconut seed lies inside the shell. It is a ball of crisp, white, sweet-tasting coconut *meat* covered by a tough brown skin. Its hollow centre holds a sugary liquid called coconut *milk*. The coconut seed measures from 20 to 30 centimetres long and from 15 to 25 centimetres across.

A well-tended tree produces about a hundred coconuts a year. Each fruit takes about a year to ripen. Ripe coconuts fall from the tree. However, on plantations, the

Leading coconut-growing countries

Tons of copra produced in a year

Philippines



1,842,000 metric tons

Indonesia



1,157,000 metric tons

India



432,000 metric tons

Mexico



183,000 metric tons

Vietnam



151,000 metric tons

Figures are based on a three-year average, 1988-1990. Source: FAO Production Yearbook, 1990 Food and Agriculture Organization of the United Nations

coconuts are usually cut from the trees every two or three months.

Solid, dried coconut meat is called *copra*. Copra contains a valuable oil that is used for cooking and to make margarine and soap. Tropical lands produce millions of tons of copra each year. About 6,000 medium-sized coconuts make just under 1 metric ton. To make copra, coconuts are split open and dried in the sun. Some coconuts are dried over a fire or by passing them through a tunnel of hot air.

Throughout the world, people enjoy eating crisp, juicy chunks of fresh coconut meat. Shredded and dried coconut meat adds a distinctive flavour and texture to sweets and other foods. People in tropical lands also use the coconut husk. They weave the short stiff fibres (called *coir*) of the husk into mats, ropes, and brooms.

Growing coconut palms. In the tropics, people can plant coconut palms throughout the year. They half bury the coconut in a horizontal position. Within six months, a leaf sprouts from one of the eyes and pushes through the husk. The young palm can be transplanted after one to four years. The palm will bear coconuts after seven or eight years. Coconut palms need much water and a temperature of at least 22° C most of the year.

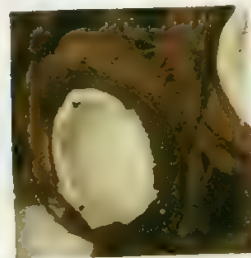
A disease called *lethal yellowing* has destroyed many coconut palms in Florida, Texas, Mexico, the Bahamas, and areas of the Caribbean. The disease is caused by microorganisms carried by insects called *planthoppers*.

Scientific classification. The coconut palm belongs to the palm family, Palmae (Arecaceae). It is *Cocos nucifera*.

See also **Copra**; **Tree** (picture); **Palm** (Kinds of palms; pictures: Coconut palms).



Coconut palms are tall trees that produce coconuts. Large leaves spread from the top of the branchless trunks.



Coconuts grow in clusters among the leaves of the coconut palm, *left*. The coconut seed lies inside the shell, *right*. It is a ball of crisp, white, sweet-tasting coconut meat covered by a tough brown skin. The seed's hollow centre holds a sugary liquid.

Cocoon is a protective covering that encloses the pupa and sometimes the larva of many insects. The mature larva prepares the cocoon as a shelter around itself. Inside the cocoon, the larva changes to a pupa and eventually transforms into an adult insect. Among the insects that spend part of their lives in cocoons are wasps, bees, caddis flies, moths, and some ants. Many spiders spin silk cocoons around masses of their eggs and sometimes around their prey.

The chief substance of most cocoons is silk. But the larva often incorporates other substances, including soil, sand grains, plant materials, and hair or waste from its own body. Some cocoons contain very little silk at all.

Most moth larvae (caterpillars) form cocoons. But many species pass the pupal stage in soil or in parts of plants without forming a cocoon. A few butterfly caterpillars make flimsy cocoons, but most pupate as a hard-shelled *chrysalis*. Perhaps the best-known cocoon is that of the caterpillar of the silk moth (*Bombyx mori*), which supplies most of the world's commercial silk.

Most moth caterpillars build their cocoons in protected places in fallen logs, openings in tree bark, or among debris and fallen leaves. Cocoons of some large species, such as *Cecropia*, *Promethea*, and *Polyphemus* moths, are fastened to the twigs of trees. The pupae



The cocoon of a *Cecropia* moth, left, is attached to a tree twig. The opened cocoon, right, reveals the pupa inside.

spend the winter inside the cocoon and secrete a dissolving fluid to emerge from the cocoon in spring or summer.

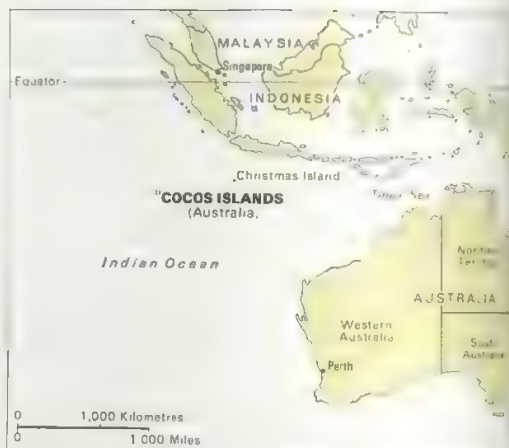
Other moths, including certain species of *tiger moths*, spend the winter as larvae and form cocoons in spring or summer before pupating. Some species of *clothes moths* form an incomplete cocoon or pupal case early in larval life and carry it on their backs as they feed. Later, they complete the cocoon and use it for their pupal stage.

Related articles in *World Book* include:

Caterpillar	Metamorphosis	Silk (Raising silk-
Chrysalis	Moth	worms)
Larva	Pupa	

Cocos (Keeling) Islands are in the Indian Ocean, 2,768 kilometres northwest of Perth, Australia. The islands are an overseas territory of Australia.

Land. There are 27 coral islands in the whole group, with a total land area of about 24 square kilometres. None of the islands rises more than 6 metres above sea level. The main islands are West Island, Home Island,



The Cocos Islands are a group of Australian islands in the Indian Ocean. The islands lie to the northwest of Perth and southwest of Indonesia.

South Island, Direction Island, and Horsburgh Island. North Keeling Island is 24 kilometres to the north of the main group. Most of the islands are densely covered with coconut palms, though North Keeling Island retains its natural vegetation. The climate is hot and pleasant. Average annual rainfall is 2,032 millimetres. April is the wettest month, and October is usually the driest month of the year.

People. The population of the islands is about 620, comprising about 390 Cocos Malays on Home Island and about 230 residents on West Island. These two islands are the only inhabited islands in the group.

The Cocos Malays are descendants of the people who were brought to the islands in the 1820s by two settlers, Alexander Hare and John Clunies-Ross. Their language is Cocos Malay. They are followers of the Islamic religion and have traditionally lived on Home Island. West Island residents are primarily people from mainland Australia on limited term contracts with various government departments.

The Cocos Islands Co-operative Society Ltd. conducts the business enterprises of the Cocos Islanders. Today, most of the Cocos Malays work in such trades as building, carpentry, repairing boats, and general maintenance. A 10-year building programme to replace existing houses on Home Island was begun in the mid-1980s.

Coconuts, grown throughout the islands, are the sole cash crop. The Cocos Malay islanders gather a certain quota of coconuts each week. Although local fishing is good and domestic gardens provide some vegetables and fruit, the soil is very poor and the islands are not yet self-sufficient. The islanders are hoping to encourage limited tourism in the future to move toward self-sufficiency. A Cocos postal service, including a bureau for the collection and study of stamps and other postal materials, has operated since 1979. Revenue from the islands' postal service is used for the benefit of the community.

Primary education is provided at schools on Home and West islands. Secondary education is provided on West Island.



The Cocos Islands group consists of 27 coral islands. None of the islands in the group rises more than 6 metres above sea level

Transport and communications. International Subscriber Dialling has replaced the radiotelephone and has brought the islands into easy contact with the Australian mainland. Australian government charter aircraft from Perth carry passengers, supplies, and mail to and from the Cocos Islands every week. The airstrip is of international standard. Cargo vessels from Perth deliver supplies at intervals of six to eight weeks. There is a noncommercial broadcasting station, Radio VKW.

Government. An administrator, appointed by the governor-general of Australia and responsible to the minister for territories, is the senior government representative in the islands. The Cocos (Keeling) Islands Council, made up of Cocos Malay representatives, was formed in 1979.

History. Captain William Keeling, of the East India Company, discovered the Cocos Islands in 1609. Alexander Hare, an Englishman, and Captain John Clunies-Ross, a Scottish seaman, established settlements in 1826 and 1827.

The islands were declared a British possession in 1857. They came under the authority of the governor of Ceylon in 1878 and of the governor of the Straits Settlements in 1886. They were annexed to the Straits Settlements and incorporated with the settlement (later colony) of Singapore in 1903. Administration of the islands was transferred to the Commonwealth of Australia in November 1955.

In September 1978, the government purchased land owned by a descendant of John Clunies-Ross in the Cocos (Keeling) Islands. In July 1979, the government passed the *kampung* (Malay village) area to the Cocos (Keeling) Islands Council.

On April 6, 1984, an act of self-determination was made by the Cocos Malay people to decide the future political status of the islands. United Nations observers were present. A large majority voted in favour of integration with Australia. As a result, the islanders have acquired the rights, privileges, and obligations of all Australian citizens.

In September 1984, the Australian government passed to the Cocos (Keeling) Islands Council the remainder of the land acquired from the Clunies-Ross family in 1978.

See also **Clunies-Ross** (family).

Cocteau, Jean (1889-1963) a French writer often used his many talents to shock the public. He had a great range of creativity and won fame as a poet, playwright, author of ballet plots, screenwriter, novelist, and artist. Cocteau defied the conventions of his time with an unorthodox private life, which included homosexuality and the use of opium. He also insisted that the artist occupies a central role in human culture.

Cocteau frequently used the myths and dramatic plots of ancient Greece in his plays. *Orpheus* (1926) is a study of a poet's agonizing search for inspiration and his struggle to gain acceptance for his work. *The Infernal Machine* (1934) is an adaptation of Sophocles' *Oedipus Rex*. Its theme is that humanity's fate is controlled by dangerous powers that govern the universe. In Cocteau's fantastic style, these plays use unexpected colloquial phrases, events out of time sequence, and symbols explainable in terms of modern psychology.

Cocteau's best-known novel, *Les Enfants terribles* (1929), tells of four young people who create a sinister, unreal world of their own. He also created ballets, notably *Parade* (1917). He wrote and directed several films, including *The Blood of a Poet* (1932), *Beauty and the Beast* (1946), and *Orpheus* (1950).

In his later years, he devoted his time to painting and to decorating chapels. Cocteau was born in Maisons-Laffitte, a suburb of Paris. He was elected to the French Academy in 1955.

Cod is a major food fish. It lives in the northern waters of the Atlantic and Pacific oceans. Cod belong to the codfish family, which also includes the pollack and the haddock. The codfish family is second only to the herring family in the amount of fish caught each year. But unlike herring, which are used largely for agricultural and industrial purposes, most cod are eaten by people.

Appearance and habits. Cod have five fins. The colour of the fish varies from grey to red to brown or black, with the upper parts marked with many small, dark spots. Adult Atlantic cod average about 0.9 metre in length and weigh from 4.5 to 11 kilograms, though some may grow much larger. The Pacific cod rarely exceeds



Jean Cocteau



The Pacific cod lives in the waters of the northern Pacific Ocean and the Bering Sea. It is an excellent food fish and has long been important to the fishing industry.

1 metre in length and weighs from 1.5 to 9 kilograms. Cod live near the ocean floor, but they sometimes approach the surface while feeding. The fish swim at an average speed of 6 kilometres per hour.

Cod *spawn* (produce eggs) in the depths of the ocean in the late winter and early spring. A cod normally spawns from 3 to 7 million eggs at a time. But only a small percentage of the eggs develop into mature fish. The eggs of most species of cod rise to the surface and become part of the *plankton*—the mass of small, drifting aquatic organisms. The newly hatched fish feed on the plankton. When the cod have grown to a length of about 7.5 centimetres, they move to the ocean's bottom, where they feed on worms and small shrimp.

Mature cod eat small fish; squid; and shellfish, such as crabs and shrimp. The Atlantic cod will also eat almost anything else it finds, including rocks and shells. Powerful juices in the stomachs of the fish digest food or sea life that may be growing on an object. Then the cod expels what is indigestible.

Cod fishing and marketing. There are 25 species of codfish, not all of which are properly called cod. Cod are abundant all year round. The Atlantic cod ranks as the most important codfish in terms of the annual catch. The best fishing grounds for Atlantic cod are the off-shore banks of North America—especially the Grand Banks, which is off Newfoundland, Canada; and Georges Bank, which is off Boston, Massachusetts, U.S.A. The most important cod fishing areas in the northeastern Atlantic are around Iceland and in the Barents, Norwegian, Baltic, and North seas.

The Pacific cod ranges from the waters off California north to the Bering Sea and west to Japan and Korea. The best fishing grounds for Pacific cod are in the southeast Bering Sea. Prior to its breakup, the Soviet Union was the leading country in catching Pacific cod. The United States ranked second and Japan third.

When cod is split, salted, and dried, it can be kept for long periods without spoiling. In past centuries, ships could not carry perishable food on long voyages because there was no refrigeration. Cod became an important food on such voyages. As early as the 1500's, European fishing crews crossed the Atlantic to catch cod. At first, the fish were caught with lines and bait. But since the 1600's, cod have been caught mainly with nets.

The demand for cod has increased sharply since the introduction of precooked fishfingers in the 1950's. In addition, the fish-and-chips business depends almost exclusively on cod. Cod is also a source of cod-liver oil, a food supplement rich in vitamins A and D.

Scientific classification. Cod belong to the codfish family, Gadidae. The Atlantic cod is *Gadus morhua*. The Pacific cod is *G. macrocephalus*.

See also Cod-liver oil.

Cod-liver oil is a yellow, fishy smelling oil obtained from the livers of codfish. It contains large amounts of the vitamins A and D. At one time, many people took cod-liver oil to protect against vitamin A and D deficiencies. People who do not receive enough vitamin A may develop skin and eye problems. A lack of vitamin D can cause *rickets*, a disease that leads to deformed bones.

Today, cod-liver oil is rarely used. A balanced diet provides all the vitamins A and D a person normally requires. For example, fortified milk is high in both vita-

mins, and green and yellow vegetables are a good source of vitamin A. People who need extra amounts of these vitamins generally take them in capsules. Such vitamin capsules are cheaper and more convenient than cod-liver oil.

Code, in law, combines all the laws on a given subject in a single statute or ordinance. It may be passed by a national or local legislative body, such as a state legislature, a county authority, or a village board. It is purely *statutory law*, as distinguished from the *common law* that arises from court decisions. In theory, it is possible for all the laws in a code to be new. That is, no law has ever been passed dealing with the particular subject. But in practice, a code nearly always represents a systematic and comprehensive revision of all the laws that the legislative body has passed on a given subject.

Statutes usually develop only as problems arise that point out the need for rules and regulations on particular points. Laws concerning cars are an example. The first rules set speed limits and required drivers to drive on one side of the road. Then vehicles, and later drivers, were licensed. Stop signs, traffic lights, and other traffic regulations were established.

Such piecemeal legislation left many gaps, uncertainties, and conflicts among the many separate regulations. As a result, many countries have put together all the rules on road traffic into a *codified* system.

In common law countries, codes are subject to interpretation by the courts, like any other legislation. So case decisions must be read with a code to determine any point of law. However, in civil law countries, codes are normally the major source of law.

See Civil law; Common law.

Code Civil. See Code Napoléon.

Code Napoléon is the name often given to the code that contains the civil, as distinguished from the criminal, law of France. In 1800, Napoleon Bonaparte appointed a commission of jurists to combine all French civil laws into one code. The code went into effect in 1804. That same year, after Napoleon became emperor of France, the code became known as the *Code Napoléon*. But its official name is *Code Civil*.

The Code Napoléon represented a compromise between the customary law of northern France and the Roman law of the south. It also compromised between the ideas of the French Revolution and older ideas. It gave new liberty to the people, but kept such ideas as the system of inheritance. The Code Napoleon influenced law in Europe, South America, the state of Louisiana, and the province of Quebec. But its influence has declined. Even in France, it has been changed by new laws and court decisions.

Code of Hammurabi. See Hammurabi.

Code of Justinian. See Justinian Code.

Codeine is an analgesic (pain-killing) drug that is usually manufactured from morphine, a drug made from opium. Codeine also can be obtained directly from opium. Its effects are similar to those of morphine except it is much less potent and retains effectiveness when administered orally. Codeine is used to relieve mild to moderate pain. It is also used as an antitussive to suppress coughing. It is rare for people to become dependent on codeine.

See also Morphine; Opium.

Codes and ciphers are methods of writing a message so that only people with a key can read it. There are many methods of putting a message in secret form. The plaintext can be *encoded* or *enciphered* to produce a *cryptogram*. The cryptogram or secret text can later be *decoded* or *deciphered*. Putting messages into code or cipher is called *cryptography*, a word that comes from Greek words for *hidden* and *writing*. *Cryptanalysis* is the art of breaking or solving codes and ciphers without the key. Cryptography and cryptanalysis make up *cryptology*.

Common cryptographic systems

Cipher systems involve either transposition or substitution, or a combination of the two. In *transposition systems*, the cryptographer rearranges the elements of plaintext—usually single letters. For example, the message LEON ARRIVES WEDNESDAY might be enciphered as ANOEL EVIRR NDEWS YADSE. In this case, the system divides the original message into 5-letter groups, then reverses the order of the letters in each group. In *substitution systems*, the elements of the plaintext—single letters or pairs of letters—retain their original positions, but are replaced by other elements. For example, LEON ARRIVES WEDNESDAY might be enciphered as EMHG YKKSTM NUMAG MNAYW. But cryptograms rarely keep their original word divisions. Instead, the ciphertext is usually sent in 5-letter groups, in this case EMHGY KKSTM NUMAG MNAYW. Extra letters, called *nulls*, fill out the final 5-letter group if needed.

Code systems are a specialized form of substitution in which the cryptographer treats syllables, words, phrases, and even whole sentences. Code systems employ *code books* that contain the code groups for a large number of words and phrases in a specialized vocabulary, such as that used in military operations. Each plaintext meaning has its own code group, usually composed of four or five letters or digits. For example, the code group BANAT might mean the word "attack," and the code group BANEV might mean the phrase "attack progressing satisfactorily." Code books also include *syllable groups*, so cryptographers can encode proper names or other words that do not appear in the book itself. *California* might be encoded with the code groups for CAL, I, FOR, NI, and A.

Transposition ciphers involve the use of a geometric design, such as a square or rectangle. The cryptographer inscribes the plaintext letters by one route in the design, then transcribes them by another route to form the ciphertext. In *columnar transposition*, the cryptographer chooses a numerical key and writes the plaintext letters under it. The columns of letters in key-number order are then taken to form the ciphertext. In the following example, the cryptographer uses the *key word* BREAKFAST, and gives each letter in it a number as it would appear in the alphabet. The first A is numbered 1, the second A is numbered 2, the B is numbered 3, and so on. The cryptographer then writes the plaintext in rows under the numbers of the key. Suppose the message is HEAVY ARTILLERY BARRAGE CAUSING SEVERE CASUALTIES AMONG OUR TROOPS. First the key word, BREAKFAST, is written, then the key numbers, and finally the text. When the columns are taken off in numerical order, the ciphertext is produced. In

order to decipher the message, a cryptographer would simply reverse the process. The final ciphertext would begin VRCVL GSRAS EERHL, and so on.

B R E A K F A S T
3 7 4 1 6 5 2 8 9

H	E	A	V	A	R	T	I
L	L	E	R	Y	B	A	R
A	G	E	C	A	U	S	I
G	S	E	V	E	R	E	C
S	U	A	L	T	I	E	S
M	O	N	G	O	U	R	T
O	O	P	S				

Monoalphabetic substitution systems employ a single cipher alphabet, consisting of two parts, a *plain component* and a *cipher component*. In this example, the letters of a key word, MONARCHY, are placed first to produce a mixed sequence for the cipher:

Plain: ABCDEFGHIJKLMNOPQRSTUVWXYZ

Cipher: MONARCHYBDEFGIJKLPQSTUVWXZ

To encipher the word AMMUNITION, the cryptographer would locate the cipher letters below the plain letters, MGGTIBSBJI.

Bilateral substitution uses a matrix such as this:

	A	E	I	O	U
B	A	B	C	D	E
C	F	G	H	I	J
D	L	M	N	O	P
F	Q	R	S	T	U
G	V	W	X	Y	Z

Here the plaintext letters have two-letter cipher equivalents. For example, ENEMY would be enciphered as BU DI BU DE GO. The cryptographer could use digits for the row and column designators, so that ENEMY might come out 10 38 10 37 59.

Polyalphabetic substitution systems employ more than one alphabet during encipherment. In the Vigenère table (named after Blaise de Vigenère, a French cryptographer of the 1500s who first described it in print), the plaintext letters appear in the row of letters at the top of

ABCDEFGHIJKLMNOPQRSTUVWXYZ

A	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
B	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A
C	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B
D	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C
E	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D
F	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E
G	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F
H	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G
I	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H
J	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I
K	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J
L	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K
M	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L
N	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M
O	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N
P	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Q	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
R	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
S	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
T	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
U	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
V	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
W	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
X	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
Y	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Z	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y

P1	A	B	C	D	E	R	E	P	U	B
	F	G	H	I	J	L	I	C	A	N
	Q	M	N	O	P	D	F	G	H	K
	V	R	S	T	U	M	O	Q	X	Z
C2	D	E	M	O	C	A	B	C	D	E
	R	A	T	B	F	F	G	H	I	J
	G	H	I	K	L	L	M	N	O	P
	N	P	Q	S	U	Q	R	S	T	U

P1	A	B	C	D	E	R	E	P	U	B
	F	G	H	I	J	L	I	C	A	N
	Q	M	N	O	P	D	F	G	H	K
	V	R	S	T	U	M	O	Q	X	Z
C2	D	E	M	O	C	A	B	C	D	E
	R	A	T	B	F	F	G	H	I	J
	G	H	I	K	L	L	M	N	O	P
	N	P	Q	S	U	Q	R	S	T	U

Digraphic substitution looks more complicated than it actually is. The cryptographer treats digraphs, or pairs of the letters of plaintext, as the elements for encipherment. The cryptographer locates the first two letters in the plain sections of a four-square matrix (marked P₁ and P₂) and then finds the cipher text in the cipher sections at the opposite corners of an imaginary rectangle. The matrix *above left* is marked for the first two letters,

and the one *above right* for the second two letters. The matrix *below left* shows the third pair, and the one *below right* the fourth pair. In this case, the plain and cipher letters are the same for the fourth pair. Using this matrix, the final message would be enciphered as follows:

Plain: AT TA CK BE GI NS AT DA WN
Cipher: UN MO BT BE AA GQ UN RO XH

P1	A	B	C	D	E	R	E	P	U	B
	F	G	H	I	J	L	I	C	A	N
	Q	M	N	O	P	D	F	G	H	K
	V	R	S	T	U	M	O	Q	X	Z
C2	D	E	M	O	C	A	B	C	D	E
	R	A	T	B	F	F	G	H	I	J
	G	H	I	K	L	L	M	N	O	P
	N	P	Q	S	U	Q	R	S	T	U

P1	A	B	C	D	E	R	E	P	U	B
	F	G	H	I	J	L	I	C	A	N
	Q	M	N	O	P	D	F	G	H	K
	V	R	S	T	U	M	O	Q	X	Z
C2	D	E	M	O	C	A	B	C	D	E
	R	A	T	B	F	F	G	H	I	J
	G	H	I	K	L	L	M	N	O	P
	N	P	Q	S	U	Q	R	S	T	U

the table, the key letters at the side, and the cipher letters within the square.

The cryptographer writes a key word over and over above the plaintext. Then the cryptographer looks down the column under the plaintext letter to find its cipher equivalent in the row that begins with the key letter. For example, if the key word is BLUE and the message is NINE PRISONERS TAKEN, the cryptographer would write these three lines:

K: BLUEB LUEBL UEBLU EBL
P: NINEP RISON ERSTA KEN
C: OTHIQ CCWPY YVTEU OFY

In *digraphic substitution*, the cryptographer treats pairs of letters as the elements of the plaintext. In the *four-square matrix* shown here, the cryptographer finds the first two letters of the message in squares P₁ and P₂. The cryptographer uses these two points to form a rectangle, and finds the first two letters of ciphertext in squares C₁ and C₂. The process is repeated for the other digraphs (see top of this page).

The German Army once used a *combined substitut-*

P1	A	B	C	D	E	R	E	P	U	B
	F	G	H	I	J	L	I	C	A	N
	Q	M	N	O	P	D	F	G	H	K
	V	R	S	T	U	M	O	Q	X	Z
C2	D	E	M	O	C	A	B	C	D	E
	R	A	T	B	F	F	G	H	I	J
	G	H	I	K	L	L	M	N	O	P
	N	P	Q	S	U	Q	R	S	T	U

a 6 × 6 bilateral matrix containing the 26 letters and the 10 digits. They then inscribed the ciphertext from this step into a transposition rectangle and took the columns of the rectangle in key order for the final cipher. In this example, the message ATTACK BEGINS AT DAWN is first enciphered as DGVXV XDGDX and this is writ-

A D F G V X	A	D	F	G	V	X
	B	2	E	5	R	L
	I	9	N	A	1	C
	3	D	4	F	6	G
	7	H	8	J	0	K
	M	O	P	Q	S	T
	U	V	W	X	Y	Z

G	E	R	M	A	N	Y
3	2	6	4	1	5	7
D	G	V	X	G	V	X
G	D	X	G	X	A	A
A	F	F	X	D	A	D
F	V	V	D	G	V	X
F	D	D	G	X	F	D

ten in the rows of the transposition rectangle. The final ciphertext will begin VXDGX GDFVD

Some cryptographic systems employ *syllabary squares* or *code charts*, and may be considered primitive code systems. With this example of a syllabary square, a message could be encrypted as it would be in using the syllabary groups of a code book.

	1	2	3	4	5	6	7	8	9	0
1	A	I	AL	AN	AND	AR	ARE	AS	AT	ATE
2	ATI	B	2	BE	C	3	CA	CE	CO	CON
3	D	4	DA	DE	E	5	EA	ED	EN	ENT
4	ER	ERE	ERS	ES	EST	F	6	3	7	H
5	8	HAS	HE	I	9	IN	ING	ION	IS	IT
6	IVE	J	0	K	L	LA	LE	M	ME	N
7	ND	NE	NT	O	OF	ON	OR	OU	P	Q
8	R	RA	RE	RED	REI	RO	S	SE	SH	
9	ST	STO	T	TE	TED	TER	TH	THE	THI	THE
0	TI	TO	U	V	VE	W	WE	X	Y	Z

tion-transposition cipher, the so-called ADFGVX system. German cryptographers began by substituting letters in

This square is only 10 × 10. If the square were increased to such dimensions as 26 × 26, with letters to

mark the rows and columns, instead of the 10 digits, the square could contain common words and perhaps even short phrases. The square would then be classed as a *code chart*.

Mechanical devices

Cipher devices mechanically encipher or decipher messages, usually on the principles of polyalphabetic substitution. Some simply consist of two rotating concentric discs, each bearing a sequence of 26 letters. The cryptographer uses one disc to locate the plaintext letters, and the other for their ciphertext equivalents. Such a *cipher disc*, with normal alphabetic sequences, would be the equivalent of the Vigenère table. The cryptographer would set the particular key letter in the cipher component against "A" in the plain component. In order to provide successive shifts in the alphabets, as the code word BLUE did in the Vigenère table, the cryptographer might use a repeating numerical pattern such as 3-1-2-5-7-2-1, 3-1-2-5-7-2-1. Or the cryptographer might begin at a prearranged initial setting and shift the discs by one position after enciphering or deciphering each letter. This *progressive alphabet system* would bring all of the alphabets into play in succession.

Sir Charles Wheatstone, a British scientist, invented a cipher device in 1867. It had two concentric discs and a gearing mechanism that automatically shifted the alphabets in an extremely irregular manner. The machine is known as the *Wheatstone cipher device*. But credit for the original invention belongs to an American, Decius Wadsworth, who built an identical cipher device in 1817.

A French cryptologist, Étienne Bazeries, invented another type of cipher device in 1891. His *cylindrical cipher device* consists of 20 numbered discs on a central shaft, each bearing a different arrangement of the letters of the alphabet. To encipher a message, the cryptographer sets up the discs in a prearranged order. The cryptographer arranges one row of the letters on the discs to form the first 20 letters of the message, then takes off any other row as the ciphertext. The cryptographer repeats the procedure for the rest of the message. To decipher the message, the cryptographer sets up the cipher message and examines the other rows for the one row that contains plaintext all the way across. Bazeries was the first to describe this cipher device in print. But credit for the original invention must again go to an American, Thomas Jefferson. In his papers, now in the collection of the U.S. Library of Congress, Jefferson described an almost identical device.

Cipher machines are extremely complicated. They usually have a typewriter keyboard, and often need electric power. Some machines produce a printed tape with the enciphered or deciphered letters. Others, like teletypewriters, automatically encipher, transmit, and decipher at opposite ends of a circuit.

Concealment systems

Concealment is not really a code or a cipher. It is a method of hiding a secret text in an otherwise innocent message or disguise. For example, the first letters of the words HAVE EXCELLENT LAUNCHING PLAN give the secret text HELP. In *open code systems*, the sender gives plaintext word equivalents to the secret text, then

inserts them in an otherwise innocent message. In the statement AUNT MARY LEFT FOR DETROIT ON FRIDAY, the words AUNT MARY might stand for "five troop ships," DETROIT might mean "Southampton," and FRIDAY might be "Monday."

Francis Bacon devised a famous concealment system. Combinations of two elements, called *a* and *b*, represent the letters of the alphabet. These two elements may be two different styles of type in a book, the arrangement of red and black cards in a deck of playing cards, or the location of light and dark chocolates in a box. For exam-

A: aaaaa	G: aabba	N: abbba	T: baaba
B: aaaab	H: aabbb	O: abbab	U-V: baabb
C: aaaba	I-J: abaaa	P: abbba	W: babaa
D: aaabb	K: abaab	Q: abbbb	X: babab
E: aabaa	L: ababa	R: baaaa	Y: babba
F: aabab	M: ababb	S: baaab	Z: babbb

ple, a writer might put a dot or underscore under some of the letters in the innocent sentence ALL IS WELL WITH ME TODAY in order to convey the message HELP.

ALL is well w ith me today
 aa bb aaba a aba ba abba
 H E L P

The *b* letters are exaggerated with underscores here.

Cryptanalysis

The art of cryptanalysis requires extensive study and experience, unusual perseverance, considerable imagination—and just plain luck. It may be impossible to solve a single short cryptogram, even if the system is fairly simple. But a cryptanalyst who has enough time, enough messages, and enough information about the correspondents and the nature of their messages, might be able to solve even a complex system.

Each language has its own individual characteristics and peculiarities. Cryptanalysts work with extensive tables of statistics of single letters, two- and three-letter combinations (called *digraphs* and *trigraphs*), and other elements of the language. They know, for example, that E, T, A, O, N, R, I, and S are the most frequent ones in English. They also use lists of frequent words and phrases and of *pattern words* that contain repeated letters, such as ATTACK and VESSEL, of the *abba* class, and DIVISION and ELEMENT, of the *abaca* class.

History

Cryptography goes back to the time of the ancient Greeks. The Spartans wound a belt in a spiral around a *scytale* (stick), wrote a message along the length of the stick, and unwound the belt. This in effect was the first transposition cipher. Only a person who had a stick exactly the right size could read the message. Julius Caesar used a simple substitution cipher. Each letter of the plaintext was replaced by the letter three positions to the right in the normal alphabet. By his system, we would encipher CAB as FDE.

Gabriel de Lavinde wrote the first manual on cryptography in 1379. Sicco Simonetta wrote the first treatise on cryptanalysis in 1474.

In the 1600's, Cardinal Richelieu invented a *grille*. He would place a card with holes in it over a sheet of paper, write his secret message in the holes, then fill in the rest of the paper to look like an innocent letter.

Only a person with an identical grille could read the secret message. One of the most successful coding machines ever made was called Enigma. It was used by the Germans during World War II (1939-1945). Allied cryptanalysts could read messages encoded with it only after they had captured an Enigma machine.

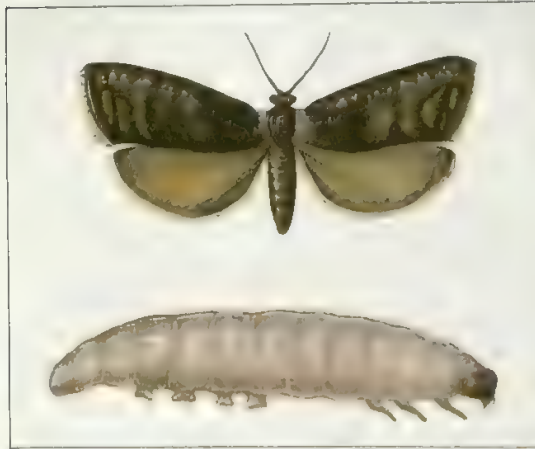
See also **Espionage; Spy; World War II** (The secret war).

Codfish. See **Cod**.

Codicil. See **Will** (Codicil).

Codling moth is a small brown and bronze-coloured moth. The caterpillars of this moth cause severe damage to apples. They also destroy such fruit as pears, quinces, and walnuts. Originally a native of Europe, the codling moth now lives in all parts of the world.

In spring, the adult moths emerge from their cocoons under loose bark and in leaf litter on the ground. They lay their eggs on leaves and twigs. The *larvae* (caterpil-



The **codling moth** is a small brown and bronze-coloured moth. As a caterpillar, it can cause damage to apples and other fruit.

lars) bore into young apples. This usually causes the fruit to die and drop off. A second or, in some areas, even a third generation of larvae may bore into larger apples.

The chief method of controlling codling moths is by means of a spray. The spray is an internationally approved control measure. It contains 17 different chemicals, including carbaryl, chlorpyrifos, cypermethrin, and diflubenzuron. The appropriate time for spraying depends on the location. Orchards and packing sheds should also be kept clean of all loose bark, fallen apples, dead leaves, and leaf litter.

Scientific classification. The codling moth belongs to the leaf roller family, Tortricidae. It is classified as *Cydia pomonella*.

Cody, William Frederick. See **Buffalo Bill**.

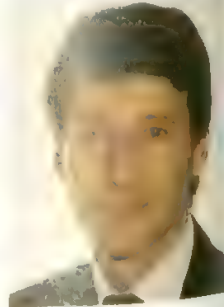
Coeducation is the teaching of males and females together in the same class or school. In many countries, state schools are generally coeducational. Independent schools often admit pupils of only one sex. However, in countries where schools are operated by religious groups coeducation is uncommon.

In the past, many schools enrolled only boys and young men. Some people thought that women had

weaker minds than men and would be disturbed by too much education. There was also a feeling that only boys needed to be educated since it was unusual for a girl to have any career other than in the home. However, many early Protestant Christians saw a need for women to learn to read their Bibles and opened schools where boys and girls were taught together.

In the late 1900's some European countries passed laws requiring coeducation in state schools at both primary and secondary level. Communist countries throughout the world have all encouraged coeducation. In order to meet the demands made by the women's movement many independent schools have become coeducational.

Coe, Sebastian (1956-), one of the United Kingdom's most outstanding athletes, won fame for his record-breaking triumphs in track events. In 1979, Coe broke the world records for the 800 metres, the 1,500 metres, and the mile races. In the 1980 Olympic Games at Moscow, he won a gold medal in the 1,500 metres and a silver in the 800 metres. During 1981, Coe twice set a world record for the mile. In 1982, Coe became the first winner of an American award, the Jesse Owens Award. In 1984, he again won a gold medal in the Olympic 1,500 metres, and a silver in the 800 metres. Sebastian Newbold Coe was born in Chiswick, west London. He graduated with an economics degree from Loughborough University before turning to full-time athletics. In 1992, Coe became Conservative member of Parliament for Falmouth and Camborne.



Sebastian Coe

Coelacanth is a primitive type of fish found in the western Indian Ocean. Scientists have found fossils of coelacanths that lived more than 300 million years ago. These fish were believed extinct until one was caught off the coast of South Africa in 1938. Since then, many more coelacanths have been caught. Coelacanths are members of an ancient group of fishes known as *sarcopterygians*. Lungfishes are the only other surviving members of this group. See **Fish** (The Age of Fishes).

Coelacanths are dark brown to blue-grey in colour. They grow to more than 1.5 metres in length and weigh up to 73 kilograms. Coelacanths have muscular, limble-



The coelacanth lives in the western Indian Ocean.

fins on the underside of their body. They apparently use these fins as a perch while resting on the ocean bottom. Coelacanth feed on other fish. Unlike most fish, the female coelacanth does not lay eggs. She gives birth to live young.

Scientific classification. Coelacanth belongs to the class of bony fish, Osteichthyes. They make up the coelacanth family, Coelacanthidae.

Coelenterate. See Cnidarian.

Coelom is the body cavity found in vertebrates and higher invertebrates. The soft internal organs, such as the liver, the kidneys, and the stomach, are suspended in the coelom.

The coelom is an important characteristic in separating the lower animal phyla from the higher phyla. The space provided by the coelom has enabled the higher animals to develop complex internal organ systems. Organs within the coelom are bathed by *coelomic fluid*. This fluid lubricates the organs and allows them to twist and slide against one another without harm.

Animals that have a coelom are called *eucoelomates*. They have a body plan that can be described as a "tube within a tube." The digestive tract forms the inner tube, and the body wall forms the outer tube. The coelom is the space between the tubes. This arrangement results from developments that occur during the animal's growth as an embryo. In its early stages, the embryo consists of a hollow sphere of cells called the *blastula*. The cavity within the blastula is called the *blastocoele*. Eventually, the cells located at one point on the blastula begin to *invaginate*—that is, they start to fold inward into the blastocoele. This tubelike invagination forms a primitive gut, lined by a layer of cells called *endoderm*. The cells on the outer wall of the blastula make up a layer called the *ectoderm*. A third layer of cells, the *mesoderm*, develops between the ectoderm and endoderm. The mesoderm completely fills what remained of the blastocoele. The coelom, a totally new cavity, develops within the mesoderm and, therefore, is lined entirely by mesodermal cells.

Certain lower invertebrates have a tube-within-a-tube body plan but lack a true coelom. These *pseudocoelomates*, including roundworms and rotifers, have a body cavity that serves some of the functions of a true coelom. In pseudocoelomate embryos, the mesodermal cells do not completely fill in the blastocoele. The blastocoele is retained and becomes the body cavity in the

adult animal. Unlike a true coelom, this pseudocoelom is not lined completely by mesoderm.

Invertebrates called *acoelomates*, which are lower than pseudocoelomates, have a solid mesodermal layer with no body cavity. Flatworms and ribbon worms are acoelomates.

Coen, Jan Pieterszoon (1587-1629), served two terms as governor general of the Netherlands Indies. In 1619, he founded Batavia (now Jakarta), the capital of Indonesia. Historians credit him with having laid the foundations of Dutch power in the Netherlands Indies.

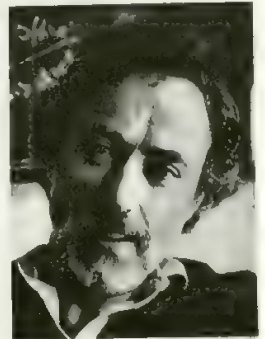
Coen was born in the Netherlands. In 1607, he sailed for the Indies in the employment of the Netherlands East India Company. In 1612, he was sent to Southeast Asia in command of two trading vessels. He remained at Banten, West Java. When Coen became governor general in 1619, he moved the Dutch headquarters from Banten to a site then called Jayakarta, which he renamed Batavia. In 1623, he returned to the Netherlands. In 1627, he began a second term as governor general. Coen died one night in 1629, when troops of the Javanese ruler, Sultan Agung, were attacking Batavia.

Coercion acts were laws passed by the British Parliament during the 1800's to strengthen the powers of the British administration in Ireland. The term is particularly applied to the Peace Preservation Act of 1833, but it is used also for other acts repeating one of its main provisions, the suspension of habeas corpus for a certain period after arrest. Since 1923, this practice has been called internment.

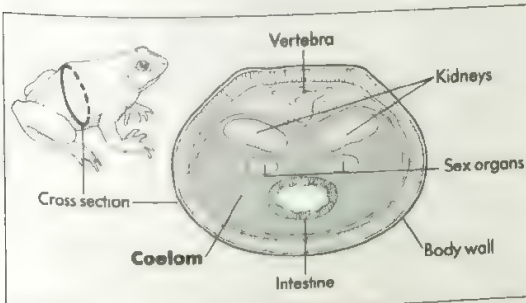
Coertse, Mimi (1932-), was the first South African opera singer to be ranked among the world's best. Maria Sophia Coertse was born in Durban, Natal. She was the daughter of a railway inspector. She showed great determination to make a career as a dramatic, coloratura soprano. In 1953, she went to Europe to further her studies and she won early acclaim for her public performances. This success led to an appointment with the Vienna State Opera in 1956. She sang there until her return to South Africa in 1973.

Coetzee, J. M. (1940-), a highly acclaimed South African writer, won the British Booker-McConnell prize for his novel *The Life and Times of Michael K* in 1983. Critics have praised him for his unusual style and the depth in which he explores his themes. His other novels include *Dusklands* (1974), *In the Heart of the Country* (1976), *Waiting for the Barbarians* (1980), and *Foe* (1987). In addition, Coetzee has written translations, linguistic studies, and literary criticism. With André Brink, a fellow South African writer, he edited an anthology of short stories, *A Land Apart* (1986). Coetzee also published a collection of essays, *White Writing* (1988).

John Maxwell Coetzee was born in Cape Town. He became a lecturer in general literature at the University of Cape Town in 1972. He became professor in 1984.



J. M. Coetzee



The coelom is the body cavity between the digestive tract and the body wall. All vertebrates and higher invertebrates have a coelom, in which many organs are located.



Coffee comes from berries, *above left*, that grow on a shrub. During most coffee harvests, workers pick the berries by hand. *left*. Each berry contains two beans. Roasted beans, *above right*, are ground up and brewed with hot water to make coffee.

called a *sluice*. Sticks, leaves, and the green and bad berries float, while the good berries sink.

Pulping. The good berries then go to a pulping house, where machinery removes the pulp. Each berry contains two *beans* (seeds). Each bean has a thin parchmentlike skin, and a second covering called the *silver skin*. At first, the uncovered coffee beans appear soft and bluish-green, but later they become hard and pale yellow. After pulping, the beans are run through a series of fermenting and washing tanks. The coffee beans are then dried and left to cure for several weeks.

Hulling and peeling make up the next step. Milling machines remove the parchment and the silver skin. As the beans come from the machine, a fan blows off the loose skins. The beans then go to a machine called the *separator*, which removes sand, dust, and small or broken beans.

Roasting. At the roasting plant, the coffee goes to the blending machine, a cylinder that mixes different types of coffee. From the blender, the beans flow by gravity to

Leading coffee-growing countries



Figures are for a three-year average: 1989-1991.
Source: Food and Agriculture Organization of the United Nations

Coffee, the drink made from the roasted and ground beans of the coffee plant, is a favourite hot drink in almost every country in the world.

The United States ranks as the largest consumer of coffee. The United States uses about 1,180,000,000 kilograms or about one-fifth of all the coffee grown in the world annually. Other leading coffee-consuming countries include Brazil, France, the United Kingdom (UK), Italy, and Japan. Brazil produces about a quarter of the world's coffee crop. Coffee is vital to the economies of many Latin-American countries.

From bean to cup

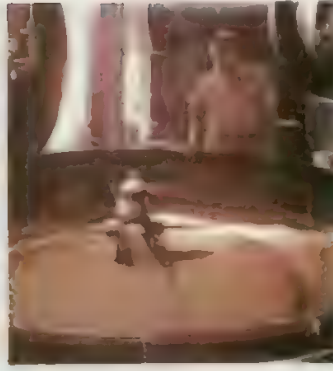
The coffee plant. The scientific name of the common coffee plant is *Coffea arabica*. It originally grew wild in Ethiopia. It is now cultivated in Java, Sumatra, India, Arabia, equatorial Africa, Hawaii, Mexico, Central and South America, and the West Indies.

Coffea arabica is a shrub with glossy, evergreen leaves. It is 4.3 to 6.1 metres high when fully grown. As a rule, coffee growers prune it to under 3.7 metres. It has white flowers that are self-pollinating.

The coffee plant's berries begin to grow while the plant is blossoming. They ripen from green to yellow to red. The average plant produces enough berries each year to make about 0.7 kilogram of roasted coffee.

A coffee plant is usually six to eight years old before it bears a full crop. The common variety grows best at altitudes ranging from 1,100 to 2,400 metres in a tropical climate. Most coffee plants grow from seeds that are first planted in nursery beds. After a year in the nursery, the seedlings are transplanted to prepared fields. Around 500 to 1,000 seedlings are planted per acre (about 1,250 to 2,500 per hectare).

Preparation for market. Most berries are hand-picked. However, some are harvested by machines that vibrate the berries off the trees. After the berries are picked, they are put through a bath of running water



Preparing coffee for market. Workers spread and shake coffee beans to remove excess moisture. *left* The beans are then dried in the sun. *centre* and left to cure for several weeks. After being shipped to a processing plant, the beans are roasted. *right* to bring out their flavour.

storage bins, then to roaster ovens. There, they are roasted at 482° C for 16 to 17 minutes. The beans lose about a sixth of their weight during roasting. The beans are then cooled and cleaned. After being ground, the coffee is packed in vacuum tins or in paper bags.

Instant coffee can be either *powdered* or *freeze-dried*. Both require adding water to make coffee.

Powdered instant coffee is made by brewing coffee in huge containers and evaporating the water from the brew. The remaining powder crystals become coffee again when water is added.

Freeze-dried instant coffee is made by converting freshly brewed coffee into an extract and freezing it in slabs. The slabs are ground into chunks and put in pressurized chambers. Moisture in the form of ice is drawn off, leaving dry coffee crystals. See *Freeze-drying*.

A good cup of coffee. Most coffee is made in *percolators*, *filter pots*, or *vacuum coffeemakers*, which strain boiling water through the coffee. The best results are obtained by using one standard coffee measure, or two level tablespoons of coffee, to each cup.

Kinds of coffee

More than a hundred kinds of coffee may be found in retail shops. They may be divided into three general groups—*Brazils*, *Milds*, and *Robustas*. The *Milds* include all *Coffea arabica* grown outside Brazil. *Coffee Robusta* is a different kind of coffee, most of which grows in Africa. Most coffee is named after the region where it grows or the port from which it is shipped. *Mocha* is named after the port of Mocha (Al Mukha) in Yemen. *Java* grows in and near Java.

Coffee roasters place great importance on the taste of their blends. Some people prefer more or less *chicory* to be added to the coffee.

Coffee contains *caffeine*, a substance that acts as a stimulant on the nervous system (see *Caffeine*). Some people find it more healthy to drink *decaffeinated coffee*. In most cases, the removal of caffeine is a cold-water extraction, done with the aid of chemicals.

History

According to legend, coffee was discovered in Ethiopia when goatherds noticed that their flocks stayed

awake all night after feeding on coffee leaves and berries. Coffee reached Arabia in the 1200's. Coffee comes from the Arabic word *qahwah*. Before its use as a beverage 700 years ago, coffee was a food, then a wine, and then a medicine.

Coffee moved from Arabia to Turkey during the 1500's, and to Italy in the early 1600's. Coffee houses sprang up throughout Europe in the 1600's. Coffee-growing was introduced in Brazil in the 1700's.

Coffee-exporting countries have tried for many years to control coffee prices and surpluses. At first, they agreed to export quotas that limited each country's exports. They also tried to control prices by stockpiling some coffee instead of exporting it. But in 1963, the United Nations helped arrange an International Coffee Agreement. Exporting countries accepted export quotas. Importing countries agreed to observe a floor on prices and to limit their coffee purchases from countries that did not sign the agreement. The agreement has had only limited success.

Scientific classification. Coffee belongs to the madder family, Rubiaceae. The common coffee plant is *Coffea arabica*.

Related articles in *World Book* include:

Brazil (picture)	Costa Rica (picture)
Burundi (picture)	El Salvador (picture)
Chicory	Ethiopia (picture)
Colombia (picture: The Andes Mountains)	Guatemala (picture)

Coffee houses were important social centres in London and leading provincial towns from the mid-1600's onward. At first, the coffee houses were open to all. They provided a social centre in which tea, chocolate, or coffee were available, but not alcohol. After the mid-1700's, some coffee houses developed into exclusive upper-class clubs. Coffee houses that were open to all came to be called *coffee shops*. The first coffee house was established in 1652.

London's coffee houses included Wilf's, to which the poets John Dryden and Alexander Pope went; Child's, used by the clergy; St. James's, used by Whig politicians; Jonathan's, used by stockjobbers; Lloyd's, "where the auctions are usually kept"; Garraway's; the Rainbow; the Grecian; Squire's; and the Cocoa-Tree. Lloyd's became a favourite meeting place for shipowners and marine un-



Coffee houses were popular meeting places for people from all social classes. The print above comes from an engraving made in the early 1800's.

derwriters, and developed into the Lloyd's of today.

See also **Lloyd's**.

Cofferdam is a temporary walled enclosure used in construction. It creates a space that protects workers and excavation sites from water and cave-ins. Cofferdams are used in building such structures as bridge piers, dams, and foundations. Simple cofferdams used in shallow water can be mounds of earth or sandbags. Cofferdams used in deeper water or deep excavations are usually made of interlocking steel sheets driven into the ground. Sometimes, they are made of closely spaced columns of wood, concrete, or metal. Such cofferdams must be braced to resist horizontal pressure from earth, water, and other sources. They may be made fairly watertight by packing clay behind the sheets or posts. See also **Caisson**; **Pile**.

Coffin. See **Funeral customs**; **Sarcophagus**.

Coffs Harbour (pop. 18,074) is a port and tourist resort on the midnorth coast of New South Wales, Australia. The district is well known for its bananas. In the 1980's, many growers began to specialise in exotic fruits, including kiwi fruit, lychees, avocados, and blueberries. Macadamia nuts and tomatoes are also grown. Fishing is an important industry. Light industries in the town include sawmilling and engineering.

Coffs Harbour has an airport that can handle jet aircraft. The Big Banana, a giant model of a banana, is a well-known tourist attraction. Other popular tourist attractions in the Coffs Harbour area include a pet porpoise pool, a working gold mine, and the port and historic jetty.

Coggan, Lord (1909–), Baron Coggan of Canterbury and Sissinghurst, was Archbishop of Canterbury, England, from 1974 to 1979. He had previously been Archbishop of York from 1961 to 1974. He represented the low church wing of the Church of England. As Arch-

bishop of Canterbury, he made moderate progress in improving relations between the Anglican and Roman Catholic churches. In 1978, he became the first Archbishop of Canterbury since the Reformation to attend a papal coronation in Rome. Frederick Donald Coggan was born in London. He was educated at Merchant Taylors' School and at Cambridge and Oxford universities. He was principal of the London College of Divinity from 1944 to 1956 and Bishop of Bradford from 1956 to 1961.

Cognac. See **Alcoholic beverage** (Brandy).

Cohan, George M. (1878-1942) was a leading figure in the American theatre during the early 1900's. Cohan wrote more than 40 plays and musicals, and he produced, directed, and starred in most of them. His shows were noted for their high spirits and distinctive American flavour.

Cohan's plays include *Broadway Jones* (1912), *Seven Keys to Baldpate* (1913), and *The Song-and-Dance Man* (1923). He wrote such musicals as *Little Johnny Jones* (1904), *Forty-five Minutes from Broadway* (1906), and *George Washington, Jr.* (1906). Cohan's shows are seldom performed today, but several of his songs remain popular. They include "I'm a Yankee Doodle Dandy," "Give My Regards to Broadway," "You're a Grand Old Flag," "Mary's a Grand Old Name," and "Harrigan." Cohan also wrote "Over There," the most popular American patriotic song of World War I (1914-1918).

George Michael Cohan was born in Providence, Rhode Island, U.S.A. As a child, he performed with his parents and sister in a popular vaudeville act called "The Four Cohans." Cohan began to write songs and vaudeville sketches while a teen-ager.

Cohen, Harriet (1895-1967) was a British pianist of international repute. She developed a deep understanding of the music of Johann Sebastian Bach and of modern composers, including Sir Arnold Bax and Ralph

Vaughan Williams. She arranged Bach's organ *Chorale Preludes* for piano. Cohen was born in London, and she studied under Tobias Matthay, a leading British piano teacher. Her right hand was severely injured in 1948. Bax wrote for her a piano concerto for left hand only.

Cohen, Leonard (1934-), is a Canadian poet and novelist. He has also won international fame as a songwriter and folk singer, setting his own poems to music. He has recorded many albums, beginning with *The Songs of Leonard Cohen* (1968).

Most of Cohen's poetry is romantic, but his romanticism is often mixed with irony and dark cynicism. He prefers metrically regular forms. His central subjects are love, death, and spiritual vision. Cohen's first book of poetry was *Let Us Compare Mythologies* (1956). Other important poetic works include *The Spice-Box of Earth* (1961), *Flowers for Hitler* (1964), *The Energy of Slaves* (1972), and *Book of Mercy* (1984). *Selected Poems 1956-1968* (1968) is a good introduction to Cohen's poetry. He has written two novels. *The Favorite Game* (1963) follows the adventures of a young poet in Montreal. *Beautiful Losers* (1966) is a lyrical dream of Montreal, combined with Canadian religious history and the nature of sainthood. Leonard Norman Cohen was born in Montreal.

Cohesion is the force that holds a material together. Cohesion results from the attraction that all atoms and molecules have for one another. This attraction decreases greatly as the distance between the molecules of a substance increases. Thus, with few exceptions, cohesion is highest in solids. Liquids have somewhat less cohesion than do solids, and gases have much less.

Because of cohesion, effort is required to separate a material in two. This effort is called the *work of cohesion*. The work required to separate the material is twice its surface tension because two new surfaces have been created (see Surface tension).

Scientists can calculate the *tensile* (breaking) strength of materials if they know the work of cohesion. These calculated strengths are very high. Actually, however, many materials can be broken relatively easily. Scientists believe this is so because of small surface cracks and other imperfections in solid materials. Glass fibres, for example, have great resistance to breakage when first manufactured, but they develop fine cracks and lose strength rapidly. High tensile strengths cannot be easily measured in liquids because the molecules flow when force is applied.

See also Adhesion; Molecule (Molecules and matter).

Cohn, Ferdinand Julius (1828-1898), was a German botanist and pioneer in bacteriology. He became the first to show that bacteria are plants. In 1872, he published the first systematic classification of bacteria into genera based upon morphology. With his help, Louis Pasteur disproved the theory of spontaneous generation (see Spontaneous generation). Cohn also contributed to the understanding of heat production by plants. He was born in Breslau, Germany (now Wrocław, Poland).

Coho. See Salmon (Kinds of Salmon).

Coll. See Ignition; Induction coll.

Coin. See Coin collecting; Money.

Coin collecting is one of the most popular hobbies in the world. Most coin collectors simply enjoy trying to acquire a complete set of a nation's coins or of one or more particular coins. Some people collect coins as



Many coin collectors mount their coins in albums. The girl shown above is using a magnifying glass to examine the details of a coin. She holds the coin by the edges to avoid staining it. Her coin catalogue, *rear*, provides information about various coins.

works of art. Others collect them as an investment, to be sold later at a profit. Through coins, a collector can also learn something about certain famous people and events in a country's history.

Imaginative coin collectors can build many types of collections. For example, they can specialize in coins of one country or in various kinds of coins, such as pennies or dollars. They can collect coins of unusual sizes or shapes. Many collectors concentrate on coins that illustrate a certain subject, such as animals, ships, or famous women.

The collecting or study of coins is called *numismatics*, and a coin collector is often called a *numismatist*. These words come from the Greek word *nomisma* and the Latin word *numisma*, both of which mean a *piece of money* or a *coin*. Numismatics includes paper money

The condition of coins

The condition of a coin plays an important part in determining its value. This table lists the terms used to describe a coin's condition, based on the amount of wear it has received.

Proof (Pf.) coins have a mirrorlike surface. They are struck especially for collectors.

Uncirculated (Unc.) coins are struck for general use but have never been in general circulation.

Extremely Fine (Ex. Fine) coins have been in circulation but show only slight wear.

Very Fine (V. Fine) coins show some wear on the highest points of the design but still have some of the original shine.

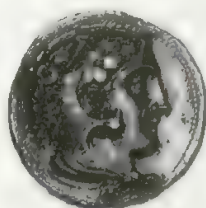
Fine (F.) coins show little wear but have no shine.

Very Good (V.G.) coins have some wear, but all the features of the design remain clear.

Good (G.) coins are worn, but the entire design can be seen plainly.

Fair coins show much wear but still have enough of the design to be identified.

Some rare and interesting coins



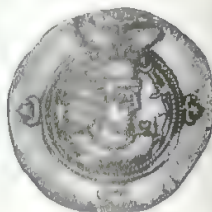
Macedonian tetradrachm
(336 to 323 B.C.)



Roman denarius
(A.D. 41 to 54)



Phoenician shekel
(126 B.C. to A.D. 66)



Persian drachm
(A.D. 590 to 627)



Frankish denier
(A.D. 888 to 898)



Indian anna
(1943)



Canadian dollar
(1935)



Vatican 20-lire coin
(1959)

and also medals, tokens, and similar objects. This article describes how to begin and care for a coin collection.

Starting a coin collection. The best source of coins for a novice collector is the change received when making various purchases. Friends also can help the beginner by letting him or her check the coins they may have—and swap money for any coins found that are not in the beginner's collection. Many new collectors go to a bank and exchange their paper money for coins. They

then examine the change to find coins for their collection.

A coin's value depends on two factors—its condition and how easily it can be obtained. The most valuable coins are both *uncirculated* (unused) and scarce. A beginner should seek easily obtainable coins at first.

As collectors learn more and more about the hobby they can start to acquire coins of greater value from several sources. For example, coin dealers and many collectors sell, exchange, and buy coins. Some collectors obtain coins through auctions held in various communities or conducted by mail. Whoever offers the highest bid for a coin is entitled to buy it. In many countries, a government agency sells uncirculated coins to collectors.

Several books for beginners can be obtained at book shops, hobby shops, and libraries. Many collectors subscribe to a specialized trade magazine.

Collecting coins of other countries offers an almost endless variety of opportunities. For example, some collectors try to acquire one coin from every country in the world. Other people build a collection of one-cent pieces from every country that issues such coins.

Two reference books, *Current Coins of the World* and *Modern World Coins*, provide information about coins from other lands. Both are edited by R. S. Yeoman. Several other books deal with coins of specific countries and regions, such as Canada and Latin America.

Many nations sell their coins in uncirculated and proof condition to collectors. A few countries have taken advantage of the interest in coin collecting. They have issued coins with designs featuring subjects that have little in common with the country. Although the



Historic coins of Australia, from left to right, include the Adelaide pound (1852) and the Sydney sovereign (1855), top row and the Port Phillip 1-ounce gold piece (1853), the holey dollar (1813), and the 1930 penny, bottom row

coins can be used as money, they do not circulate because they cost much more than their face value. These coins are called *Non-Circulating Legal Tender*.

Many collectors specialize in coins from ancient Greece, Rome, or Palestine. Various ancient coins, especially those of Greece, are prized for their beauty and craftsmanship. Some collectors specialize in coins issued in Europe during the Middle Ages.

Caring for a coin collection. Coins should be protected from dust, fingerprints, and moisture, and from objects that could scratch them. A coin should be touched as little as possible. If one must be handled, it should be held by the edges and never put on the palm of the hand. Moisture from a person's skin can stain a coin.

Many shops sell albums in which to keep coins. Some collectors put their coins in metal cabinets that have trays lined with soft cloth. Others use small envelopes designed to hold coins.

Collectors should avoid cleaning their coins. Rubbing a coin to remove dirt or stains may increase the amount of wear on the metal and thus reduce the coin's value. A coin also may be scratched accidentally while being cleaned.

For more information about coins, see the *World Book* article on **Money** and its list of *Related articles*. **Coke** is a hard, greyish substance obtained when soft coal is heated in an airtight coke oven. It is hard and *porous* (full of tiny holes), and, in most cases, contains 87 to 89 per cent carbon. Coke produces intense, smokeless heat when it burns.

Coke is made by heating *pulverized coal* (coal ground to a powder) in an airtight oven. As the coal heats, it *decomposes* (decays). It cannot burn completely without

air. Coal tar and coke oven gas evaporate from the decomposed coal and are drawn out of the oven. The escaping tar and gas form the pores in the coke. The hot coke is taken out of the oven and cooled with water at a *quenching tower* to keep it from burning in the air.

Coke is valuable in *smelting* (melting) iron ore. Coke used in smelting is called *metallurgical coke*. Over 95 per cent of such coke is made in giant coking plants with *by-product ovens* equipped to save coal tar and coke oven gas. These ovens hold from 3.6 to 18 metric tons or more of coal. Some metallurgical coke is made in older ovens called *beehive ovens* because of their shape. These do not save coal tar or coke oven gas.

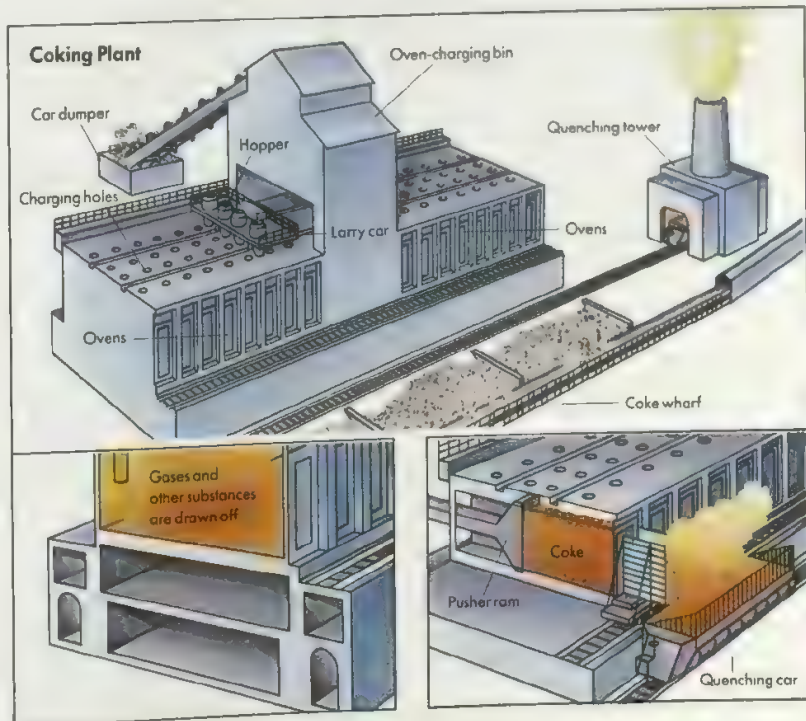
See also **Coal**; **Coke oven gas**; **Gas** (How gas is manufactured); **Iron and steel** (Raw materials); **Petroleum coke**.

Coke, Sir Edward (1552-1634), was an English barrister and judge. He rose to prominence as Speaker of the House of Commons in 1593. In 1594, Coke was selected over Sir Francis Bacon as Queen Elizabeth I's attorney general, and, in 1606, he became chief justice under King James I. As chief justice, Coke insisted that even the king was subject to the law. His famous *Institutes and Reports* (1600-1615) include many principles of modern law. Coke was born at Mileham, in Norfolk, England.

Coke, Thomas William (1752-1842), Earl of Leicester of Holkham, was one of the first British agriculturists to improve land and farm produce by the rotation of crops, and by the use of root crops to feed livestock. He helped improve the breeds of Devon cattle, Southdown sheep, and Suffolk pigs. He was the first to grow wheat instead of rye in western Norfolk, England. He was born at Holkham, in Norfolk, and represented Norfolk in Parliament. He was made an earl in 1837.

From coal to coke

Coal is converted to coke in the ovens of huge coking plants, *top*. Coal is transferred from a *car dumper* to the *oven-charging bin*, which feeds it into containers called *hoppers*. A *larry car* dumps the coal from the hoppers through *charging holes* into each oven. In the ovens, *lower left*, the coal is heated, and gases and other substances are drawn off. After 12 to 18 hours, all of the coal has been converted to coke. The oven is then opened, and the *pusher ram* shoves the coke into a *quenching car*, *lower right*. This car brings the coke to the *quenching tower*, *top*, where it is cooled with water. The coke is then dumped onto a *coke wharf* before being screened for size and shipped.



Coke oven gas, also called *coal gas*, is the gas obtained when coal is heated in an airtight place. It consists mainly of hydrogen and methane. Coke oven gas is burned to produce heat in industrial plants and in homes. It was formerly used for illumination.

Coke oven gas is made by heating coal in a *byproduct coke oven* that heats to about 1100° C. As the coal heats, coke oven gas and other by-products are given off. The gas leaves the oven through pipes and is stored in large tanks called *gas holders*. See **Gas** (How gas is manufactured).

Cola nut. See **Kola nut**.

Colbert, Jean Baptiste (1619-1683), a French statesman, served King Louis XIV as superintendent of finance for 22 years. A believer in firm government control over the economic life of the country, Colbert worked to make France financially strong. He encouraged commerce and internal improvements such as canals and roads. He built a powerful navy and sent explorers and colonists to America. Many French industries received his support.

Colbert's efforts to keep the budget balanced failed when his rival, the Marquis de Louvois, the war minister, persuaded Louis XIV to embark upon an expensive series of wars. Colbert was born in Reims.

See also **Louis XIV**.

Colbung, Ken (1930-), an Aboriginal organizer, became chairman of the Australian Institute of Aboriginal Studies in 1984. Kenneth Desmond Colbung was born at Moore River Government Settlement and brought up in an orphanage in Perth, Western Australia. He attended primary school from 1936 to 1939 and then took up rural work. He was in the Australian Army from 1950 to 1965, serving in Korea and rising to the rank of sergeant. From 1965 to 1970, Colbung worked for the Foundation for Aboriginal Affairs in Sydney. From 1970 to 1972, he managed the Western Australian Aboriginal Advancement Council community centre in Perth.

Colchester (pop. 141,100) is a local government district and town in northeast Essex, England. The district is mainly agricultural, and arable farming is important. Near Colchester, nurseries specialize in rose growing. On the coast, West Mersea is a small residential town and holiday centre. Wivenhoe, on the River Colne, is a busy cargo dock. It is also the site of the University of Essex, which was founded in 1962.

The town of Colchester, situated on the River Colne, is the district's administrative centre. It has several light industries, including engineering, but is noted for its oyster industry. The town has a large army barracks. In Roman times, it was a garrison town called *Camulodunum*. It was the first Roman colony in Britain and has many Roman remains.

Colchicum is a poisonous plant which grows wild in the moist meadowlands of England, Ireland, and of middle and southern Europe. It is sometimes called the meadow saffron. Its flowers range in colour from purple to white and bloom in the autumn. Florists call the flowers, which look much like those of the *crocus*, *autumn crocus*. *Colchicum* is easily grown when planted in light, moist, sandy loam.

Colchicine, a bitter drug taken from the *colchicum* plant, is used in small quantities to treat gout and rheumatism. Botanists use the drug in experiments in hered-



The colchicum is a poisonous European plant. Its flowers range in colour from purple to white and bloom in the autumn.

ity. Colchicine causes the number of chromosomes in a cell to double. This doubling causes plant offspring to become much larger than their parents.

Scientific classification. The *colchicum* plant belongs to the lily family, Liliaceae. It is *Colchicum autumnale*.

See also **Crocus**.

Cold. See **Climate**; **Heat**.

Cold, Common. The common cold is any of a number of infections of the upper respiratory tract. It is the most widespread and common of all diseases. Although many people consider colds to be minor illnesses, they are a major cause of absence from both school and work.

Scientists have made great progress in identifying the more than 100 viruses that give rise to these illnesses. They have found that one of the reasons people have so many colds is that different viruses can cause similar illnesses. Also, one cold does not give immunity against another.

People of all ages are susceptible to colds. But children—and adults living with children—seem to be most susceptible.

Symptoms. Colds are infections of the mucous membranes of the nose, throat, and, sometimes, of the air passages and lungs. A person with a cold usually has a stuffy nose and may have difficulty breathing. The infection may spread to the ears, sinuses, and eyes. In many cases, it spreads to the throat, causing soreness and hoarseness. When colds spread to the air passages and lungs, they may cause bronchitis and pneumonia.

The simplest kind of cold lasts a few days. More severe colds may last longer, often causing fever and aches and pains throughout the body. Occasionally the patient also has chills and loss of appetite.

Colds can be dangerous because they make people more susceptible to other infections. They are especially dangerous to the elderly and to people who have lung ailments or are weakened by poor health.

Treatment. There is no specific treatment for colds. But a doctor often prescribes drugs to relieve the discomfort caused by cold symptoms. For example, aspirin or other pain-relieving drugs may be given to lessen

muscular aches and pains. Nasal sprays or drops shrink the mucous membranes and may help the patient to breathe more easily. Vaporizers also may provide relief. A patient who has a fever should stay in bed. This provides rest and isolates the patient from other people.

People with colds should eat nourishing foods and drink plenty of fluids, such as fruit juices, tea, or water. If the cold persists or seems to get worse, a doctor should be called. If complications begin to develop, the doctor can treat them early. Often the doctor prescribes antibiotics to control bacterial complications.

Spread. Doctors believe that most colds are caught by *droplet infection*. Whenever a person with a cold coughs or sneezes, tiny droplets of moisture that contain cold germs spray out into the air. Anyone who breathes the air can "catch" the cold. For this reason, colds seem to spread most rapidly in places where many people gather together, such as in schools, offices, theatres, or buses. A person should always cover the mouth and nose when coughing or sneezing. Then the germs cannot spray out into the air. Doctors also believe that cold germs can be spread by direct contact, especially by the hands.

Prevention. Colds are transmitted by people who have them. Therefore, isolating people who have colds is one of the best ways to prevent colds from spreading.

Although scientists have developed several vaccines for cold viruses, especially influenza virus, none has proved effective against all types of colds. However, influenza vaccines should be given to people who risk becoming seriously ill by getting a cold.

The cells of human beings produce chemical substances called *interferons* that help fight cold viruses. Scientists have found ways of obtaining interferons by genetic engineering. See **Interferon**.

See also **Cold sore**; **Influenza**.

Cold-blooded animal is an animal that has no built-in control over its body temperature. Many cold-blooded animals, including most water animals, are warm when their surroundings are warm, and cool when their surroundings are cool. Almost all animals are cold-blooded except birds and mammals, which are warm-blooded. Some cold-blooded animals control their body temperature to some extent by varying their activities. For example, the body of an active moth produces so much heat by muscular action that the animal becomes somewhat warmer than its surroundings. Most cold-blooded land animals adjust their body temperature by their behaviour. These animals move into sunlight when they become too cool and move into shade when they become too warm. Scientists refer to cold-blooded animals as *ectothermic* or *poikilothermic*.

See also **Warm-blooded animal**.

Cold frame is a boxlike structure built on the ground to protect plants during cold weather. Gardeners use cold frames in spring to shelter tender seedlings that have sprouted before the start of the growing season. Cold frames also extend the growing season of plants in the autumn by protecting them from frost.

A cold frame consists of a rectangular structure made of wood, concrete, or brick, with a cover of glass or transparent plastic. The cover lets in sunlight and retains heat. Most cold frames have a cover that slants downward toward the south, in order to let in as much sun-



A cold frame is built on the ground to shelter plants. The slanted, transparent cover lets in sunlight and retains heat. A layer of gravel under the soil helps drain the growing area.

light as possible. On warm days, one side of the cover can be raised to cool the frame. The growing area is prepared by replacing about 30 centimetres of soil with equal layers of gravel and rich soil.

In summer, plants that need shade can be protected from bright sunlight in a frame that has been covered with wooden slats or burlap (a type of coarse fabric). A structure similar to a cold frame but heated by electricity or other means is called a *hotbed* (see **Hoibed**).

Cold sore is a cluster of small blisters caused by a virus called *herpes simplex virus*. Cold sores can occur anywhere on the body. However, they appear mostly on the face, especially on or near the mouth. In many cases, they develop when a person has a cold or a fever.

In most cases, the herpes simplex virus that causes cold sores enters the body through the mouth or nose. The sores begin with itching, tingling, pain, and redness. Then the blisters appear. They soon break open, leaving yellowish crusts. The sores heal by themselves two to seven days after the blisters break open.

Many people suffer repeated attacks in which cold sores form in the same places. Most likely, these repeated attacks occur because the virus remains in the body after the sores heal. The dormant virus usually causes no symptoms, but certain conditions can reactivate it and produce new cold sores. These conditions include fever, overexposure to sunlight, emotional upset, and injury on the site of a previous sore.

Cold sores cannot be prevented. Doctors sometimes prescribe a drug called *acyclovir* for people who have frequent cold sores. This drug hinders outbreaks but does not cure the disorder.

See also **Herpesvirus**.

Cold storage is a method of storing foods and other perishable products by keeping them at low temperatures above freezing and in moist air. Low temperatures prevent spoilage by checking the growth of most harmful bacteria and slowing undesirable chemical reactions. Household refrigerators and commercial walk-in refrigerators used by grocers, butchers, restaurants, and warehouses generally keep food at 0° to 5° C. However, even at these temperatures, most fresh foods can only be preserved for about one to four weeks. Furs can also be kept in cold storage during the summer. Florists use

cold storage to store flowers, plants, and bulbs. Pharmacists, doctors, and scientists use it to preserve drugs, serums, medicines, and specimens for research. See also **Food, Frozen; Refrigeration.**

Cold War is the term used to describe the intense rivalry that developed after World War II in 1945 between groups of Communist and non-Communist nations. On one side were the Union of Soviet Socialist Republics (U.S.S.R.) and its Communist allies, often referred to as the *Eastern bloc*. On the other side were the United States and its democratic allies, usually referred to as the *Western bloc*. The power struggle was called the *Cold War* because it did not actually lead to fighting, or "hot" war, on a wide scale.

Beginnings of the Cold War. From 1941, when Germany attacked the Soviet Union, there was a military alliance between the Soviets and the Western Allies (the United States, the United Kingdom (UK), France, and other democratic nations). The Yalta Conference of 1945 toward the end of World War II marked the high point of wartime unity and goodwill between the Allies and the Soviet Union. Soviet leader Joseph Stalin was determined to control the countries in Eastern Europe freed from German occupation by Soviet armies. The Soviet Union refused to honour the Declaration on Liberated Europe, in which the Allies promised to hold democratic elections in the liberated countries.

After the war ended, the Soviet Union cut off nearly all contacts between the West and the territories it controlled in Eastern Europe. British Prime Minister Winston Churchill warned that "an Iron Curtain has descended across the continent" of Europe. By 1948, Bulgaria, Romania, Hungary, Poland, Czechoslovakia, Albania, and Yugoslavia all had Communist governments. East and West opposed each other in the newly formed United Nations (UN), particularly over the question of nuclear weapons.

The West adopted a *containment* policy to hold back Communist expansion. U.S. President Harry S. Truman declared in March 1947 that the United States would help any free nation resist Communist attack.

In 1948, the Western Allies announced plans to unify their occupation zones in Germany and establish the German Federal Republic (West Germany). The Soviet Union responded by blockading the German city of Berlin. For 11 months, Allied planes airlifted food and supplies into Berlin, until the Soviet Union lifted the blockade in May 1949. The Russian zone in Germany became the Communist-governed German Democratic Republic (East Germany).

In 1949, the Allies agreed to form the North Atlantic Treaty Organization (NATO), a military alliance designed to defend West Germany and to prevent Soviet expansion. Also in 1949, the U.S.S.R. set up the Council for Mutual Economic Assistance (COMECON). This organization was designed to unite the Communist-ruled states of Europe under Soviet leadership. In August 1949 the Soviet Union tested its first atomic bomb. This increased the fear and mistrust between the two sides. The Communist victory in China, when Mao Zedong's forces drove out the Nationalist armies of Chiang Kai-shek late in 1949, added a new element to the Cold War.

The Cold War continued after the death in 1953 of Stalin. The Korean War extended the West's policy of



The Berlin airlift of 1948-1949 defeated an attempt by the Soviet Union to force the Western Allies out of West Berlin.

containment of Communism to the Far East. In 1952, the United States tested its first hydrogen bomb. The U.S.S.R. set off its first H-bomb in November 1955. Military alliances were strengthened. West Germany joined NATO in 1955. In response, the U.S.S.R. and its Eastern European allies signed the Warsaw Mutual Defence Pact, a military alliance (see **Warsaw Pact**). In 1954, the United States and seven other nations signed the Southeast Asia Collective Defence Treaty (see **Southeast Asia Treaty Organization**).

In 1956, Soviet leader Nikita Khrushchev called for *peaceful coexistence* (competition without war) between East and West. But talks between Khrushchev and U.S. President Dwight D. Eisenhower, in 1960, failed after a U.S. U-2 spy plane was shot down while photographing Soviet territory.

Tensions between East and West were heightened by the Hungarian uprising of 1956, the building of the Berlin Wall in 1961, the Cuban missile crisis of 1962, and the Soviet invasion of Czechoslovakia in 1968. From the 1960's, the U.S. involvement in the Vietnam War at times threatened to turn the Cold War into a general hot war.

There were some agreements between East and West. In 1963, the United States, the U.S.S.R., and the UK approved a treaty to stop the testing of nuclear weapons in the atmosphere, in outer space, and under water. The United States and the U.S.S.R. set up a *hotline* (direct telecommunications link) to reduce the risk of accidental nuclear war.

By the 1970's, the United States and the Soviet Union realized there would be no victor in an all-out nuclear war. Within both blocs, there were growing splits. The Soviet Union and China quarrelled. In Eastern Europe, some countries sought greater independence from Soviet control. France withdrew its troops from NATO command. The European Community increased trade with the Eastern bloc. Japan began acting more independently of U.S. policies.

The status of Berlin was finally settled in 1972, and both East and West Germany joined the United Nations. In 1973, China was admitted to the UN. In 1971, China and the United States established diplomatic relations.

In 1972, the first Strategic Arms Limitation Talks (SALT) agreement was reached between the United States and the U.S.S.R. The Soviet invasion of Afghan-

stan in 1979 threatened to revive Cold War hostility. The United States increased defence spending. But the missile-reduction agreement between Soviet leader Mikhail Gorbachev and U.S. President Ronald Reagan in 1987 appeared to signal an easing of tension.

The end of the Cold War. In 1988 and 1989, the U.S.S.R. withdrew its troops from Afghanistan. Also in the late 1980's, the Soviet Union began to reduce its conventional military forces in Eastern Europe. In the U.S.S.R., Gorbachev allowed more democracy and freedom of expression. He also encouraged similar actions in Eastern Europe. In 1989, Communist rule came to an end in a number of Eastern European countries, including Poland, Hungary, East Germany, and Czechoslovakia. Germany was reunified in 1990. In 1991, the Soviet Communist party lost control of the Soviet government and the Soviet Union broke up into a number of independent, non-Communist states. Many people believe that such events marked the end of the Cold War.

Related articles in *World Book* include:

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Communism	International Relations	Nuclear weapon (The Cold War)
Democracy	Iron Curtain	Peace
Disarmament	Korean War	Vietnam War
Espionage	Marshall Plan	
Europe (History)		

Cole, G. D. H. (1889-1959), was a British economist, political writer, and novelist. His books include *Organized Labour* (1924), *Gold, Credit and Unemployment* (1930), *The Intelligent Man's Guide Through World Chaos* (1932), *Principles of Economic Planning* (1935), *Socialism in Evolution* (1938), and *A Century of Co-Operation* (1945). He collaborated with his wife, Margaret Isabel Cole, on political works and detective stories. George Douglas Howard Cole was born at Ealing, in west London. He was president of the Fabian Society from 1952 until his death (see *Fabianism*).

Cole, Nat "King" (1917-1965), was an American singer and pianist. During the early 1940's, Cole was considered one of the leading jazz pianists of his day. His trio, with guitar and bass, inspired Ahmad Jamal, Oscar Peterson, Art Tatum, and other pianists to form groups with the same instruments. Cole's vocal recording of "Straighten Up and Fly Right" (1943) won him fame as a singer. He continued to perform as a jazz musician, but his image as a singer dominated the rest of his career. Cole's vocal hits include "It's Only a Paper Moon" (1943), "The Christmas Song" (1946), "Nature Boy" (1948), and "Mona Lisa" (1950).

Cole was born in Mont-



Nat "King" Cole

gomery, Alabama, and brought up in Chicago. His original name was Nathaniel Adams Coles. In 1946, his trio became one of the first black music groups to have its own radio show. In 1958, he portrayed composer W. C. Handy in the film *St. Louis Blues*. His daughter, Natalie Cole, also became a successful singer.

Cole, Thomas (1801-1848), was a leader of the first group of American landscape painters. Cole helped develop a distinctly American style of landscape painting. He painted dramatic, panoramic scenes of the American wilderness in a romantic way.

Cole first gained fame in 1825 for his paintings of scenes along the Hudson River Valley in New York. His paintings stimulated other artists of his time to paint American landscapes. This group became known as the Hudson River School. Some of Cole's paintings illustrate symbolic stories with moral themes. These works include the five canvases of *The Course of Empire* (1836) and the four works entitled *The Voyage of Life* (1840).

Cole was born in Lancashire, England. He and his family moved to the United States in 1818. Cole studied painting at the Pennsylvania Academy of the Fine Arts from 1823 to 1825.

See also *Hudson River School*.

Colebee was an Aborigine from Port Jackson, on the east coast of Australia. He was captured, together with Bennelong, another Aborigine, by Captain Arthur Phillip in November 1789. Phillip hoped to keep them in the British settlement and train them as interpreters and mediators between the settlers and the Aboriginal tribes in the Sydney area. But Colebee escaped shortly afterwards and Bennelong somewhat later. Bennelong later rejoined the settlement, but Colebee remained with his tribe.

See also *Bennelong*.

Coleman, John (1928-1973), an Australian Rules football player, kicked 537 goals in a little over five seasons playing for Essendon, a suburb of Melbourne. He became the only league forward to score 100 goals or more in each of his first two seasons. He scored 100 goals in 1949 and 120 goals in 1950. After he retired, he coached the Essendon team. He was born at Port Fairy, in Victoria.

See also *Australian Rules football*.

Coleoptera. See *Insect* (table; pictures: Order Coleoptera).

Coleraine (pop. 51,060) is a local government district in Northern Ireland. The town of Coleraine itself, the district's administrative capital, is an industrial centre and a market town and port. Farmers in the rural areas grow oats and potatoes and raise cattle, pigs, and poultry. Industries in Coleraine district include salmon and eel fishing, textiles, and the manufacture of shirts and Irish whiskey. The district also includes the resorts of Castlerock, Portrush, and Portstewart. A campus of the New University of Ulster is at Coleraine.

Coleridge, Samuel Taylor (1772-1834), was a poet and philosopher-critic of the English romantic movement. His major poems are among the most original in English. His poem "The Rime of the Ancient Mariner" is one of the greatest in English literature. His literary criticism has influenced nearly all later critics.

His life. Coleridge was born in Devon, England, the youngest of about 14 children of a clergyman. He stud-

ied at Cambridge University, where he met Robert Southey in 1794. The two young poets favoured the principles of the French Revolution and planned to found a *pantisocracy* (a utopian society) in America. They also collaborated in 1794 on a drama opposing the principle of monarchy.

In 1795, Coleridge met William Wordsworth, and they became intimate friends. Together they published *Lyrical Ballads* (1798), which contains the first version of "The Rime of the Ancient Mariner." In 1798, Coleridge received an *annuity* (regular income) from Josiah and Thomas Wedgwood, which enabled him to travel to Germany. There he absorbed ideas from German philosophers that influenced his own literary theories. On his return to England, he translated two plays by the German author Friedrich Schiller.

About 1800, Coleridge's health began to fail seriously. He had begun taking opium to relieve the pain of rheumatism. His marriage, never happy, also caused him increasing distress after he fell in love with Wordsworth's sister-in-law, Sara Hutchinson. Coleridge sought relief from his suffering in drugs and travel. He delivered a series of lectures in London on the principles of poetry and founded a short-lived periodical, *The Friend*. In 1813, he gave another series of lectures and produced his play *Remorse* with the aid of Lord Byron. He spent his last years under a doctor's care, largely to control his addiction to opium.

His writing. Coleridge's other famous poems are "Kubla Khan" and "Christabel." Coleridge said, possibly incorrectly, that "Kubla Khan" was inspired by an opium dream. "Christabel" is an unfinished narrative of medieval times. Both poems deal with the visionary and the supernatural. Each combines dreamlike vividness of imagery with rich literary references and intricate symbolism.

Coleridge blended keen psychological insights with precise pictures of natural scenes in his meditative lyrics, notably "Frost at Midnight," "This Lime Tree Bower My Prison," and "Dejection: An Ode."

In his literary criticism, Coleridge established the principle that a good poem is an organic, not a mechanical, unity. Therefore, a poem cannot be *paraphrased* (expressed in other words). He emphasized that poetry is creative or expressive, rather than imitative, and insisted that imagination, rather than reason, is the foundation of the fine arts.

Coleridge's best-known work of criticism, *Biographia Literaria* (1817), contains valuable analyses of Wordsworth's poetry. Many of Coleridge's shrewdest critical comments appear in his notebooks, lectures, journalistic essays, and marginal comments on other writers' works. A devout man, he wrote and talked much about religion, morality, and theology.

See also **Ballad** (The ballad style).

Coleridge-Taylor, Samuel (1875-1912), a British composer, is best remembered for his choral and orchestral setting of Longfellow's poem *Hiawatha*. In this work, his feeling for rich and colourful use of the orchestra is shown at its best. He wrote many other works for various ensembles and several works for the theatre. Coleridge-Taylor was born in London. He was the son of a West African doctor and an English mother. He studied at the Royal College of Music, in London. Later, he

distinguished himself as a conductor in Britain and the United States.

Colet, John (1467?-1519), was an English scholar, teacher, and priest who influenced the revival of learning and the reformation of the Church in England. Colet was also a founder of the modern approach to Biblical studies.

Colet studied at Oxford University, and afterward in Paris and Italy. Later, he applied principles of secular scholarship to sacred texts, and in particular to the Epistles of St. Paul. In his lectures and writings, he interpreted Paul's letters as historical documents written by a man trying to teach Christianity to a non-Christian world. This idea went against the traditional view that all sacred texts were divine statements.

As a priest, Colet preached against the worldliness of the clergy and the church courts. He also opposed other abuses, including the worshipping of religious relics. Colet's radical views incurred suspicions of heresy.

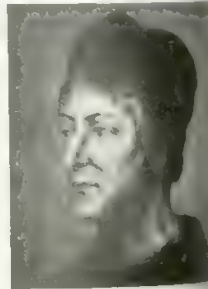
Colet was born in London. He was the son of a wealthy merchant. In 1505, he became Dean of St. Paul's London. In 1509, he founded St. Paul's School, also in London.

Colette (1873-1954) was a French author. She was one of her country's few modern novelists who expressed closeness to nature in her writing. Her mother had taught her tenderness for every plant and animal, and Colette expressed these feelings in her novels. Her style is sensitive and sensual and brings out the perfumes and colours of her native region of Burgundy. She also portrayed Parisian life.

Colette is especially noted for her portraits of women in love and of jealous women. Her novels reflect her own life in the early 1900's. But she saved her characters and situations from appearing outdated by the vitality of her insight into human nature.

Colette was born Sidonie-Gabrielle Colette in St. Sauveur-en-Puisaye, near Auxerre. Her first works were four autobiographical novels (1900-1904) about a girl named Claudine. Colette's other novels include *The abandoned* (1910), *Chéri* (1920), *The Ripening* (1923), *Sido* (1929), *The Cat* (1933), and *Gigi* (1945). One hundred of the author's short stories written between 1908 and 1983 were published in *The Collected Stories of Colette* (1983).

Coleus is a large group of showy foliage plants, native to the African and Indian tropics. Coleuses grow as big



John Colet



Colette

as 90 centimetres, and have many-coloured leaves. See also Gardening (picture: Some popular house plants).

Scientific classification. The coleus belongs to the mint family Labiatae (Lamiaceae). It forms the genus *Coleus*.

Colic is a severe cramping pain resulting from the contraction of any of the hollow, muscular abdominal organs, such as the stomach and intestines. Many babies and some children and adults suffer from colic. Doctors do not fully understand the causes of such pains, especially in babies. The disease may occur if the baby's digestive system has not developed enough to handle its food properly. Indigestion or constipation may cause gas to form in the intestines, resulting in colic. Some people develop colic as a result of emotional tension. The disorder may also be caused by arsenic or lead poisoning, blood diseases, gallstones, kidney stones, intestinal worms, or appendicitis.

Treatment for colic depends on the cause. Patting a baby's back gently may help bring up any wind. In some cases, it may be necessary to change the kind or amount of a baby's food. In most cases, babies outgrow the disease. Medical help should be sought if colic persists. Adult sufferers may require psychiatric counselling.

Coliseum, an alternative spelling. See Colosseum.

Colitis is a disease involving inflammation of the colon or other parts of the large intestine. There are three main types of colitis: (1) ulcerative colitis, (2) amoebic colitis, and (3) mucous colitis.

Ulcerative colitis can occur in people from 20 to 40 years old. Doctors do not know what causes the disease, but many believe that nervous tension and other psychological factors may make the illness worse. The patient suffers severe diarrhoea, often accompanied by fever and rectal bleeding. As ulcerative colitis progresses, ulcers develop in the lining of the colon and cause scarring. Drugs often help reduce the inflammation, but surgical removal of the colon may be required in extremely severe attacks. A prolonged case of ulcerative colitis greatly increases the possibility of getting cancer of the colon. Many doctors recommend surgery if the disease has persisted for more than 10 years.

Amoebic colitis results from consuming food or water contaminated by a certain type of parasitic amoeba. Symptoms of amoebic colitis include abdominal cramps, diarrhoea, and fever. Deep ulcers may form in the colon and may even perforate it, causing *peritonitis* (see Peritonitis). Physicians treat amoebic colitis with drugs, and surgery is not necessary in most cases unless perforation occurs.

Mucous colitis, also called *spastic* or *irritable colon*, is caused by spasms of the muscles in the wall of the colon. The patient may have severe cramps, and the faeces may contain mucus—but no blood. There is no inflammation present and the general health is not affected. Doctors use certain drugs and diets to relieve the symptoms.

See also Colon; Diarrhoea; Dysentery; ileitis.

Collage is a picture or design made by gluing pieces of paper or other materials onto a canvas or another surface. The term comes from the French word *coller*, meaning to paste or to glue.

Artists often use such common items as photographs and ticket stubs to make collages. The pasted materials may be combined with lines and colours painted by the



Max Ernst, 'The Bottle of Anis del Mono', 1920. In: *The Art of the Collage*, New York, 1920.

Collages broke down traditional differences between painting and sculpture and influenced many art styles of the mid-1900s.

By arranging the materials in a certain way, an artist can create effects not possible in traditional painting.

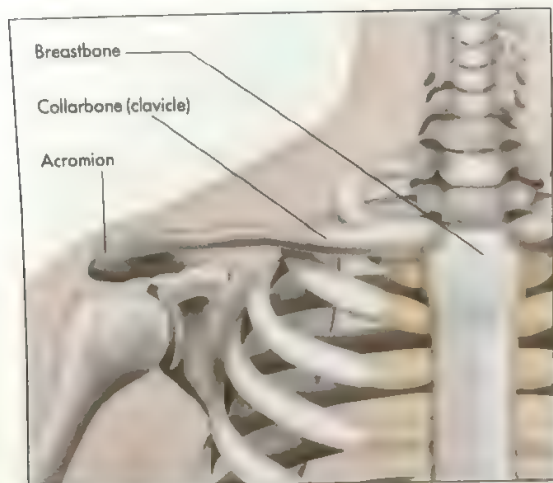
Some painters use collage to develop colour compositions. For example, an artist can move a piece of coloured paper over parts of a picture until the colour is where the artist wants it. Art students use collage techniques to study proportion and colour relationships. Many schools and colleges include collage in their art courses.

Modern artists began experimenting with collage about 1912. Georges Braque, Juan Gris, and Pablo Picasso created paintings onto which they pasted pieces of paper, oilcloth, or wallpaper. In *The Bottle of Anis del Mono*, Gris used pieces of newspaper and a liqueur bottle label. This picture appears in the Painting article. Beginning about 1920, such painters as Max Ernst cut out book and magazine illustrations for collages. They pasted parts of one picture onto sections of another to create mysterious fantasies.

Collagen is a protein found throughout the bodies of human beings and animals. Collagen provides strength and gives shape to connective tissues—such as ligaments and tendons, and to bones. It also provides much of the strength and flexibility in skin and blood vessels.

There are many kinds of collagens in the body. All of them are made by cells and secreted into the *intercellular substance* (material outside the cells). Single collagen molecules can come together and form larger structures. This process results in the formation of tissues.

Collagen is destroyed by injuries, such as cuts and broken bones. A major part of the process by which wounds heal involves the removal of damaged collagen, the formation of new collagen, and the shaping of this



The collarbone, or clavicle, connects the breastbone with the acromion, a projection of the shoulder blade. The collarbone holds the arm in its proper position at the side of the body.

new collagen into a tissue. Many of the problems of arthritis are caused by damage to the collagen in cartilage and bone. In certain inherited disorders, collagen is abnormal. Patients with these disorders may have fragile, rubberlike skin and very loose joints. In other diseases of collagen, the bones are easily broken or the skin blistered by normal activities of life.

Animal collagen has many uses. Gelatin is made from collagen and is used in foods and glues. Collagen is used in shampoos and other cosmetics. In medicine, collagen is used to make artificial heart valves and to repair scars and wrinkles.

Collarbone is a long, slender, curved bone that connects the breastbone with a hooklike projection on the shoulder blade. The technical name for the collarbone is *clavicle*. The breastbone is properly called the *sternum*, the hooklike projection, *acromion*, and the shoulder blade, *scapula*.

Humans have two collarbones, one to support each shoulder. The bones are shaped somewhat like the italic letter *f*. They hold the arms in their proper position at the sides of the body. When a person breaks a collarbone, the shoulder drops downward and forward toward the chest. Most broken collarbones are caused by falling on the shoulder. A hard blow on the shoulder also may break the collarbone or tear ligaments at the joints between the clavicle, the acromion, and the sternum.

Animals that walk on four legs, such as dogs, have no collarbones. Those that hang from trees, such as apes, have large collarbones. Occasionally, humans are born without collarbones.

See also Human body (Trans-Vision picture).

Collards are the leaves of the collard plant, a vegetable related to the cabbage. The collard resembles kale, and can grow in warmer climates than ordinary kale (see Kale). The collard is native to the Mediterranean and Atlantic coasts of Europe. It thrives in mild, maritime climates. It is grown in Europe and in the Southern United States. The collard plant may grow to a height of 60 to

120 centimetres. In warm climates, the seeds may be planted in September and the leaves picked the following spring and summer. Seeds may also be planted in summer and the leaves picked the following winter. Collards are cooked and eaten. They provide a rich source of vitamin A.

Scientific classification. Collards belong to the mustard family, Cruciferae. It is *Brassica oleracea*.

Collecting. See Hobby (Collecting).

Collection agency is an organization that collects overdue payments. Many businesses and individuals use a debt collection agency instead of spending their own time trying to collect such debts. The agency receives a fee or commission, usually based on the amount it collects.

A collection agency deals with a debtor chiefly through letters and telephone calls. At first, an agency may merely urge the payment of a bill so that the debtor's credit rating does not suffer. Each successive letter or call is firmer in its demand for payment.

If the debtor does not pay, the agency may take legal action to secure payment. But in some cases, depending on the size of the debt, the agency tells the *creditor* the person to whom the money is owed that the money cannot be collected. The creditor then decides what legal action to take, if any.

Collective bargaining. See Industrial relations; Strike (Functions of strikes); Trade Unions.

Collective behaviour is a term in sociology that refers to how people act in crowds and other large, relatively unorganized groups. The various types of collective behaviour include fads, panics, and riots. Collective behaviour often arises in situations that stimulate people's emotions. These situations include sporting events, protest demonstrations, and disasters.

Much collective behaviour is impulsive, unplanned, and brief. Thus, it differs from the more predictable, longer-lasting actions of such organized groups as school classes, teams, and social clubs. However, some types of collective behaviour fit into organized social frameworks. For example, an organized political party or social movement might use mass demonstrations as a device in seeking social change.

Before the 1900s, scientists knew little about the forces at work in collective behaviour. During the 1890s Gustave Le Bon, a French physician and social scientist, made one of the first psychological studies of crowds. The American sociologists Robert E. Park and Ernest W. Burgess introduced the term *collective behaviour* in their book, *Introduction to the Science of Sociology* (1921).

Collective behaviour occurs in so many forms that social scientists have reached few conclusions about its origins, development and consequences.

See also Group dynamics; Riot; Vandalism.

Collective community. See Communal society; Kibbutz.

Collective farm is a farm operated by a group cooperatively. The farm may be owned jointly by the group, by individuals in the group, or by the government. In most collective farms, workers receive a share of the farm's profits, some of its products, and a small wage. In many countries, the workers also help manage the farm. Collective farms differ from state farms, which the gov-

ernment owns and runs much as it would a factory. On state farms, the government pays the workers a wage and, in some cases, gives them a small portion of the farm's products.

Collective farms were introduced in Russia after Communists gained control of the country in 1917. Beginning in 1929, Soviet dictator Joseph Stalin forced millions of peasants to give up their land and join government-controlled collective farms. Later, he combined some of these farms to create state farms. Soviet leaders thought that the collective and state farms would be more efficient and productive than the tiny family farms they replaced. After World War II ended in 1945, new Communist governments in China, North Korea, and most of the countries of Eastern Europe imitated the Soviet system.

But the collective and state farms in Communist countries proved to be inefficient and unpopular. Most farmers resented their low earnings and the government's tight control over production. As a result, production remained below government expectations, and food shortages became common.

In the late 1980's, non-Communist governments replaced Communist governments in many countries of Eastern Europe. In 1991, the Soviet Union broke up into a number of independent, non-Communist states. Most of the Eastern European countries and some of the states that had been part of the Soviet Union began to move toward a system based on private land ownership.

Collectivism is a political and economic system in which the government or the people as a group own the land, factories, and other means of production. Collectivism originated during the early 1800's as a revolt against *capitalism*, the most popular economic system of the time. Capitalism called for individual ownership of property and little government intervention in business. Collectivists claimed these ideas led to poverty, unemployment, and other hardships for workers. Such writers as Robert Owen of Great Britain and Charles Fourier of France called for a new economic system based on cooperation and collective ownership. (See **Communal society**.)

Several forms of collectivism developed during the late 1800's. They included *syndicalism*, which called for workers to own and manage industries, and *cooperatives*, which are businesses owned by the people who use their services. Major modern forms of collectivism include *communism* and *socialism*.

See also **Cooperative**; **Socialism**; **Syndicalism**.

College of Arms is a body consisting of 13 members who act officially in matters concerning heraldry in England, Wales, Northern Ireland, and the Commonwealth. They also examine genealogies and record family trees. The college negotiates the granting of new armorial bearings to individuals and corporations and confirms existing coats of arms. It has its headquarters at Herald's College, in the City of London. Scottish heraldry is dealt with by the Court of the Lord Lyon in Edinburgh. Heraldry in the Republic of Ireland is dealt with by the Genealogical Office in Dublin.

See also **Genealogy**; **Herald**; **Heraldry**.

Collembola. See **Insect** (table).

Collie is a breed of dog that originated in Scotland, probably during the 1600's. Scottish farmers used the dog to guard and control flocks of sheep. Like other



A long-haired collie has a coarse coat.

sheepdogs, collies have a thick, double, weatherproof coat. Their intelligence, willingness to work, and good eyesight equip these dogs for taking care of sheep. The dogs became popular as pets after Queen Victoria of England brought several collies to the royal residence at Windsor Castle in the 1860's.

The most common variety of collie has a coarse, long-haired coat. Another variety has a smooth, short-haired coat. A collie may be sable-brown; brown and white; black, white, and tan; or blue *merle* (blue-grey with flecks of black). The dogs stand about 55 to 65 centimetres high and weigh from 23 to 34 kilograms. The Collie is also used as a guard dog, as a rescue dog, and as a guide dog for the blind.

Collie, Alexander (1793-1835), a Scottish-born naturalist and surgeon, arrived in Western Australia in 1829 on the warship *Sulphur*. The *Sulphur* accompanied the *Parmelia*, which carried the first settlers to the colony. Collie, together with Lieutenant Preston, explored the area south of the Swan River. The two men named the Collie, Preston, and Margaret rivers. Collie served as colonial surgeon from 1832 to 1835. He was born in Aberdeenshire, in Scotland.

Collingwood, Lord (1750-1810), Cuthbert Collingwood, was a British admiral who played a prominent part in the wars against revolutionary and Napoleonic France. He served as Nelson's second-in-command at the decisive Battle of Trafalgar in 1805. Collingwood succeeded Nelson in command of the Fleet and remained in this post until his death. He was born at Newcastle upon Tyne in northeast England, and is buried in St. Paul's Cathedral, London.

Collins, David (1756-1810), was the founder of Hobart, the capital of Tasmania, Australia, and the first lieutenant governor of Van Diemen's Land (now Tasmania). In 1803, the government sent him to establish a settlement at Port Phillip Bay in Victoria, Australia. Collins found the area unsuitable and moved to Van Diemen's Land, taking command of a settlement at Risdon Cove. In 1804, Collins moved the settlement to Sullivan's Cove, where Hobart now stands. Collins was born in Exeter, England. He landed with the First Fleet in 1788 and became the first judge advocate of New South Wales.

Collins, Gerard (1938–) was minister of foreign affairs for the Republic of Ireland for the second time from 1989 to 1992. He first held the post from March to December 1982. His other posts in Fianna Fáil governments included minister of justice from 1977 to 1981 and again from 1987 to 1989.

James Gerard Collins was born in Limerick, and educated at University College, Dublin. He was first elected to Dáil Éireann in 1967.

Collins, Michael (1930–), an American astronaut, was a crewman on the Apollo 11 mission, which made the first manned landing on the moon. Collins piloted the command module, *Columbia*, as it orbited above the moon. His fellow astronauts, Neil A. Armstrong and Edwin E. Aldrin, Jr., landed on the moon on July 20, 1969.

Collins was born in Rome, Italy. He became an astronaut in 1963. Collins was the pilot of the Gemini 10 flight in 1966. He resigned from the astronaut programme in 1970. In 1971, Collins became director of the Smithsonian Institution's National Air and Space Museum.

Collins, Michael (1890–1922), was one of the chief leaders in Ireland's struggle for independence. With Arthur Griffith, he headed the Irish delegation that negotiated the Treaty of 1921 in London, and was one of the signatories of the treaty.

Collins was born near Clonakilty, in County Cork, Ireland. At the age of 15, he moved to London, where he joined the Irish Republican Brotherhood, a nationalist group. Returning to Ireland in 1916, he took part in the Easter Rising and was later imprisoned in England. After his release, he joined the Irish Volunteers and became a Sinn Féin member of Parliament in 1918. In 1919, Sinn Féin set up *Dáil Éireann* (the Irish Parliament) with Collins as Finance Minister. From 1919 to 1922, Collins helped to organize Irish resistance.

In 1922, *Dáil Éireann* ratified the treaty setting up an Irish Free State, but many members voted against it. The supporters formed a provisional government under Collins. In the Civil War of 1922 and 1923, Collins was commander-in-chief of the national army. Republican soldiers assassinated him near Bandon, in Cork.

See also *Ireland, History of*.

Collins, Wilkie (1824–1889), an English author, was one of the most successful writers of detective fiction in the 1800s. *The Woman in White* (1860) and *The Moonstone* (1868) rank as his best and most popular novels.

Some critics rank *The Moonstone* among the world's outstanding detective stories. Sergeant Cuff, a character in the novel, was one of the first detectives in English fiction. The book is about a diamond called the moonstone which is stolen from the forehead of an image of the moon-god of India. A curse, and sometimes murder, follows the diamond until it is returned.

William Wilkie Collins was born in London. He became a barrister in 1851, but never practised law. However, he used his knowledge of law in writing his books. Collins gained his first literary success with *Antonina* (1850), a historical novel set in ancient Rome. In 1851, he met Charles Dickens and the two became close friends. Collins' first important mystery novel, *The Dead Secret* (1857), appeared in Dickens' magazine *Household Words*.

Collodi, Carlo (1826–1890), an Italian author, wrote the famous children's story *The Adventures of Pinocchio*

(1883). His real name was Carlo Lorenzini. He took the pen name *Collodi* from the village where he spent much of his youth. Collodi was born in Florence and worked as a journalist for many years. He also wrote humorous fiction for adults and many children's stories.

In Collodi's famous story, *Pinocchio* is a wooden puppet carved by a kindly old man named Geppetto. The puppet comes to life and has many unhappy adventures because he is lazy and selfish. At the end of the story, *Pinocchio* has learned to be generous and honest and to work hard. As a reward, a fairy grants his wish and turns him into a real boy.

Colloid is a material composed of tiny particles of one substance that are *dispersed* (distributed), but not dissolved, in another substance. The mixture of the two substances is a *colloidal system*. A colloidal system composed of solid or liquid particles dispersed in a gas is called an *aerosol* (see *Aerosol*). A system made up of solid or liquid particles in water is sometimes called a *sol* or a *hydrosol*. The word *colloid* is often used alone to mean *colloidal system*. The remainder of this article uses *colloid* in this way.

Colloids include such familiar products as milk, soap solutions, paint, and ink. Other common products, such as pottery and paper, are made from colloids. Blood and most other fluids in living things are colloids.

The solid particles of a colloid may be crystals, groups of molecules, or large, single molecules. At least one dimension of a typical colloidal particle measures between a few nanometres and a few thousand nanometres. One nanometre equals one billionth of a metre. Some individual particles are too small to see, even with an optical microscope. These particles scatter light, however, producing bright dots that are visible in an *ultramicroscope* (see *Ultramicroscope*).

Liquid colloids can be divided into three groups: (1) lyophobic, (2) lyophilic, and (3) association.

In lyophobic colloids, the particles have little attraction for the liquid in which they are dispersed. As a result, the particles tend to *coagulate* (clump). Mixing a chemical called a *dispersant* with a lyophobic colloid can decrease this tendency; however, for example, dispersants minimize the coagulation of pigments that give certain inks their colour.

In lyophilic colloids, there is an attraction between the particles and the liquid, so the particles have little tendency to coagulate. Many animal and plant fluids, such as blood and gums, are lyophilic colloids.

In association colloids, the colloidal particles are large molecules that are part lyophilic and part lyophobic. These molecules form clusters called *micelles* that turn their lyophobic parts away from the liquid molecules and expose only the lyophilic parts. Soaps and detergents are association colloids. Their micelles surround and hold oily pieces of dirt.

Colloquialism. See *Slang*.

Colobus is a type of monkey that lives in Africa south of the Sahara to the Zambesi River. Adult colobus monkeys weigh from 3 to 14.5 kilograms, depending on the species. They measure from 40 to 80 centimetres long, not including a 50- to 100-centimetre tail. Males are larger than females in most species. Colobus monkeys have a stocky build. Their fur may be black, black and white, red, or olive. Unlike most other monkeys, colobus



The **colobus** is a type of monkey that lives in Africa. The animal has a stocky build, and many have black and white fur. The monkeys live mainly in trees but often travel on the ground.

bus monkeys have no thumbs. Many scientists recognize ten species of colobus monkeys.

Most colobus monkeys live in a variety of forested environments, including tropical rain forests, wooded mountain areas, and patches of forests along rivers. They live mainly in trees but frequently travel on the ground. Colobus monkeys are called "leaf-monkeys" because they eat chiefly leaves. They also eat fruit, flower buds, bark, and other plant parts.

Colobus monkeys live in groups that range from about 3 to 80 members. Most groups consist of a few adult males and several adult females and their young. Some groups have only one adult male. Black-and-white colobus monkeys aggressively defend their territory from other groups. Red colobus monkeys generally do not defend their home areas.

The number of colobus monkeys has declined significantly since the late 1800's because of the hunting of the monkeys for their fur and the clearing of forests for settlements and agriculture. In some regions, entire populations of colobus monkeys have been eliminated.

Scientific classification. Colobus monkeys belong to the Old World monkey family, Cercopithecidae, genus *Colobus*.

See also **Monkey** (picture: Red colobus).

Cologne (pop. 916,153) is a city in western Germany. For location, see **Germany** (political map). Its German name is Köln. Cologne lies along the Rhine River. It is the largest city in the state of North Rhine-Westphalia. It is also the chief industrial, commercial, and cultural centre of the large region called the Rhineland.

The *Ringstrassen*, a network of semicircular roads, forms Cologne's boundary line. These roads replaced the city's medieval fortified walls. Most of Cologne's commercial and residential areas lie on the west bank of the Rhine River. Most of the industrial areas are on the east bank. The city has numerous museums, theatres, libraries, and schools of higher education.

Cologne Cathedral is the city's most famous landmark. A magnificent Gothic structure, the cathedral features

two 157-metre spires and beautiful stained-glass windows. It was started in 1248, but was not completed until 1880. The cathedral is the largest Gothic church in northern Europe. Cologne's numerous other medieval buildings include the old City Hall. Cologne University was founded in 1388.

Cologne's major industries include metal processing and the production of cars, beer, chemicals, electric power, motors, pharmaceuticals, and petrochemicals. A world-famous perfume called *eau de Cologne* was originally made in Cologne, and is now produced both there and elsewhere. Cologne has long been an important river port and railway centre, and it has a large, modern airport. It is also a centre of the insurance business in Germany.

Roman soldiers established a settlement on the site of what is now Cologne not long before the birth of Jesus Christ. The Ubii, an ancient Germanic people, had lived there long before the Romans arrived. Roman officials made the settlement a colony in A.D. 50. Norman invaders destroyed Cologne during the late 800's. The city was rebuilt in the 900's. From then until the 1500's, it prospered as an important member of the Holy Roman Empire (see **Holy Roman Empire**). France occupied Cologne from 1794 to 1815, when Prussia took the city. In 1871, Cologne became part of the newly united nation of Germany.

During World War II (1939-1945), Allied bombing attacks destroyed many parts of Cologne and forced most of the residents to leave. However, most of the people returned after the war, and the destroyed and damaged areas were soon rebuilt.

See also **Gothic art** (picture).

Cologne, a perfume. See **Cologne; Perfume**.



Majestic Cologne Cathedral rises along the west bank of the Rhine River in Germany. The city of Cologne is an important industrial, commercial, and cultural centre.



Bogotá, Colombia's capital and largest city, lies in a basin high in the Andes Mountains. Steep mountains rise east of the city. The cable car in the foreground carries sightseers to one of the mountaintops for a spectacular aerial view of Bogotá.

Colombia

Colombia is a country in northwestern South America. It is the only country on the continent with a coast along both the Atlantic Ocean and the Pacific Ocean. Colombia is one of South America's largest countries in population. It ranks fourth in area among the countries of South America. Only Brazil, Argentina, and Peru cover a larger area than Colombia.

Colombia's landscape and climate offer striking contrasts, ranging from the snow-capped peaks of the Andes Mountains to hot lowland plains. The equator crosses southern Colombia. Yet parts of the country have a chilly climate because of their mountainous nature.

The population of Colombia is distributed extremely unevenly. Most of the people live in valleys and basins of the Andes Mountains. Bogotá, Colombia's capital and largest city, lies in a basin of the Andes.

The differences in climate throughout Colombia enable farmers to grow many kinds of crops, including coffee, rice, bananas, and potatoes. Colombia produces more coffee, its most valuable crop, than any other country except Brazil.

Colombia's economy depends heavily on agriculture, though manufacturing is growing in importance. Colombia has huge supplies of many raw materials used in industry and enormous sources of energy. However, the country has not been able fully to develop its vast resources.

During the early 1500's, Colombia's natural wealth, especially its gold, attracted Spanish explorers. The Spaniards conquered most of the Indians, the region's original inhabitants. Colombia remained a Spanish colony for nearly 300 years. After gaining independence in 1819, the country suffered long periods of violence and civil

war. But unlike a number of other Latin American countries, Colombia has a tradition of democratic government.

Colombia was named after the Genoese navigator Christopher Columbus. The nation's official name is República de Colombia (Republic of Colombia).

Government

Colombia is a republic. The nation's Constitution was adopted in 1886 and has been revised numerous times. All citizens 18 years of age and older may vote in Colombia's elections.

National government. A president, elected by the people to a four-year term, heads Colombia's government. The president may be elected to any number of

Facts in brief about Colombia

Capital: Bogotá.

Official language: Spanish.

Area: 1,138,914 km². *Greatest distances:* northwest-southeast 1,883 km; northeast-southwest 1,368 km. *Coastline*—933 km along the Pacific Ocean; 1,143 km along the Caribbean Sea.

Elevation: *Highest*—Cristóbal Colón 5,775 m above sea level. *Lowest*—sea level, along the coasts.

Population: *Estimated 1996 population*—35,624,000; *density*—31 people per km²; *distribution*—73 per cent urban, 27 per cent rural. *1985 census*—27,837,932. *Estimated 2001 population*—38,329,000.

Chief products: *Agriculture*—bananas, beef cattle, cassava, coffee, cotton, maize, milk, potatoes, rice, sugar cane. *Manufacturing*—cement, chemicals, metal products, processed foods and beverages, textiles and clothing. *Mining*—coal, emeralds, gold, iron ore, natural gas, petroleum, salt.

Money: *Currency unit*—Colombian peso. (One peso = 100 centavos.)

terms but not to two terms in a row. A presidential candidate must either hold a high government office or practise a profession that requires a university education. Colombia has no vice president. Congress, the nation's legislature, consists of a 114-member Senate and a 199-member House of Representatives. Voters elect senators and representatives to four-year terms.

Local government. Colombia is divided into 23 departments, 9 national territories, and the Special District, which consists of Bogotá. Each department has a governor appointed by the president and an assembly elected by the people. The territories are thinly settled areas, chiefly in eastern Colombia. The president appoints the head of each territory. A mayor appointed by the president governs the Special District.

Politics. Two parties have long dominated Colombian politics. They are the Conservative Party and the Liberal Party. Both parties follow moderate policies.

Courts. The Supreme Court is Colombia's highest court. It has 28 justices, who serve life terms. The country is divided into 27 judicial districts. Each district has a superior court headed by a Supreme Court justice.

Armed forces. Colombia's army has about 57,000 members, its navy about 8,500, and its air force about 4,200. All men 18 years old must register for compulsory service.

People

Population. Nearly all of Colombia's people live in western Colombia, mainly in valleys and basins of the Andes Mountains. Only about 2 per cent live in the hot lowlands of eastern Colombia. For Colombia's total population, see the *Facts in brief* table with this article.

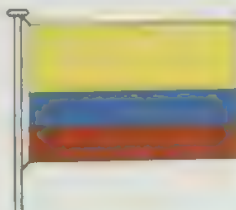
Bogotá, the capital, is Colombia's largest city. It has about 4 million people. Two other Colombian cities, Cali and Medellín, have more than a million people each. Rural Colombians, who are called *campesinos*, have poured into the nation's large cities since the 1940's in search of a better life. Many *campesinos* lack the education and skills needed for city jobs. As a result, Colombia's large cities have such problems as poverty, unemployment, slum housing, and high crime rates.

Ancestry. Many indigenous people lived in what is now Colombia when the first Spanish colonists arrived in the 1500's. The Spaniards conquered the people, known as "Indians", and later brought in black slaves from Africa. Over the years, many indigenous people, Spaniards, and blacks intermarried. Today, *mestizos* (people of mixed white and native ancestry) make up from 50 to 60 per cent of Colombia's population. *Mulattoes* (people of mixed black and white ancestry) account for 15 to 25 per cent. *Zambos* (people of black and native ancestry) make up about 3 per cent of all Colombians. About 20 per cent of the people are of unmixed European ancestry, chiefly Spanish. About 4 per cent are of unmixed black ancestry, and about 1 per cent are of unmixed native ancestry.

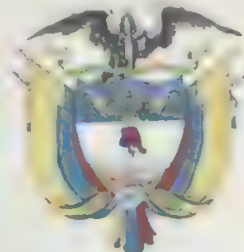
Language. Nearly all Colombians speak Spanish, the country's official language. Colombians closely guard their language to keep it from changing. They even passed a law to protect it from unnecessary change. Colombians consider their Spanish purer than that of other Latin-American countries. The traditional languages of Colombia's original inhabitants have largely died out.



Masked and costumed Colombians parade down the streets of Barranquilla during carnival. The colourful festival of carnival is celebrated just before Lent in many Roman Catholic countries.



Colombia's flag, adopted in 1861, has a yellow stripe for the golden New World, a red stripe for the blood shed for independence, and a blue stripe for the Atlantic Ocean.



The coat of arms, adopted in 1834, is topped by a condor. It shows a pomegranate, horns of plenty, a liberty cap, and the Isthmus of Panama (once part of Colombia)



Colombia lies in northwestern South America. It borders five other countries, the Pacific Ocean, and the Caribbean Sea.

Colombia map index

Departments*

Antioquia	3,888,067.	C	2
Atlántico	1,428,601.	A	2
Bolívar	1,197,623.	C	2
Bogotá	1,097,618.	D	3
Caldas	838,094.	D	2
Cauquetá	214,473.	F	3
Cauca	795,838.	E	1
César	584,631.	B	3
Chocó	242,768.	C	1
Córdoba	913,636.	B	2
Cundinamarca	1,382,360.	D	2
Guajira	255,110.	A	3
Huila	647,756.	F	2
Magdalena	769,141.	B	2
Meta	412,312.	E	3
Nariño	1,019,098.	F	2

Norte de Santander	883.884	B	3
Quindío	377.860	D	2
Risaralda	625.451	D	2
Santander	1.438.226	C	3
Sucre	529.059	B	2
Tolima	1.051.852	E	2
Valle del Cauca	2.847.067	E	1

San Andrés y Providencia	35,936†		
Vaupés	18,935	F	4
Victoria	13,770	D	4

Barran-			
quilla	899 781	.A	2
Bello	212 861	.D	2
Bogotá	3 982 941	.D	3
Bucara-			

Copacabana	40.500
Corozal	44 de 1
Cucuta	379.473
Dos Que-	

Special district

Bogotá	3,982,941	D	3
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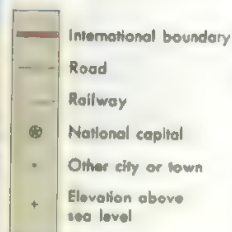
National territories*

Amazonas . . .	30,327	C	3
Aruca . . .	70,085	C	4
Casanare	110,253	D	4
Guainía	9,214	E	4
Guaviare	35,305	F	4
Putumayo . . .	119,815	F	2

Cities and towns

Aguachica	48,824	C	3
Arjona	37,033	B	2
Armenia	187,130	D	2
Armero	29,394	D	2
Aruaca	21,279	C	4
Baranoa	33,647	A	2
Barranca- bermeja	153,295	C	3

Colombia



Physical features

[illegible]

Source: 1981 census

Way of life. In general, city dwellers in Colombia live better than country people. The cities have most of the nation's schools, medical facilities, and cultural activities. The majority of middle- and upper-class Colombians live in cities.

In Colombia's large cities, tall office and apartment buildings are replacing the traditional Spanish-style architecture. Spanish-style buildings are low, sprawling adobe structures with red tile roofs and patios.

Many rural Colombians build simple houses from locally available materials. In the warm, wet coastal regions, for example, they use bamboo poles and palm leaves to build well-ventilated houses. But in the cooler mountain zones, many houses have thick adobe walls.

Many Colombian families are large. Rural families especially include numerous children. Family ties are strong. Several generations may live in the same household or as neighbours. In general, women in Colombia have far less freedom than men do, particularly among the upper class.

Most members of Colombia's small upper class are descended from the country's Spanish settlers. They form a tightly knit group and socialize mainly with other members of the upper class. Their wealth has traditionally come chiefly from large rural landholdings. But today, more and more upper-class Colombians make their money in business and industry.

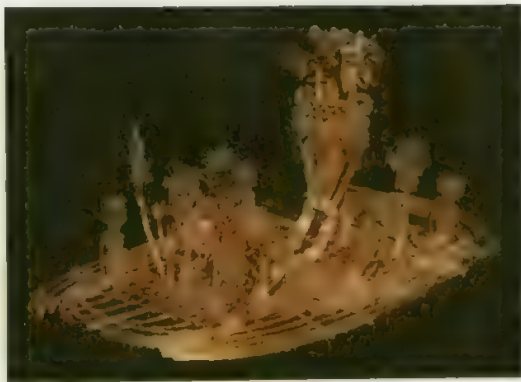
In Colombia's cities, the size of the middle class and the working class is growing as developing industries provide many new jobs. The middle class includes business people, government officials, and such professionals as doctors, lawyers, and engineers. Middle-class Colombians live in comfortable homes in attractive neighbourhoods. Working-class people include shop assistants, factory and construction workers, and other Colombians with low-paying jobs. Many of them live in run-down buildings in older neighbourhoods.

Crowded slumlike squatter settlements stand at the edges of Colombia's large cities. They are called *tugurios*. Most *tugurios* have no running water, electricity, or sewers. Many newcomers from rural areas build shacks in the *tugurios* out of tin, cardboard, and other scrap materials. Some children in these areas run away or are abandoned by their parents, who cannot support them. These homeless children, called *gamines*, roam the streets. Most are boys.

Education. The Colombian government estimates that about 80 per cent of the nation's adults can read and write. The government requires all children from the ages of 7 to 11 to attend school. However, many rural children cannot meet this requirement because their schools have only two or three classes. Colombia has about 40 universities. The National University in Bogotá is the largest university.

Clothing. Most of Colombia's city dwellers dress much like people in other Western countries. Most rural people have few garments, and some of them wear shoes only on special occasions. In chilly mountain areas, many Colombians wear woollen *ruanas* (blankets with a slit in the middle for the head).

Food and drink. Different regions of Colombia have their own special dishes. In general, however, Colombians eat much starchy food, such as potatoes, rice, and noodles. They enjoy stews and thick soups. A favourite



The Raft of El Dorado is an example of the elegant sculptures made by Indian goldsmiths hundreds of years ago. It represents the coronation of a new Chibcha ruler. The ruler was covered with gold dust to represent a god and then rowed out on a lake and washed free of the gold to represent a human ruler.

soup, called *ajiaco*, contains potatoes, chicken, maize, and *cassava* (a root crop). Poor Colombians eat little meat and few fresh fruits or vegetables.

Both adults and children drink *agua de panela*. This is a simple beverage consisting of brown sugar dissolved in water. Colombians also drink much of the beer brewed in the country. Although Colombia is a leading coffee producer, most Colombians do not drink as much coffee as people in some other countries.

Recreation. Soccer is by far the most popular spectator sport in Colombia. Bullfights and car races also draw large crowds. Swimmers and sunbathers enjoy the beaches along the Caribbean coast, and the snow-capped slopes of the Andes attract skiers. Folk songs and dances preserve the traditional music and dances of the Indians, Spanish colonists, and black African slaves.

Religion. Nearly all Colombians are Roman Catholics, and most of them actively practise their religion. The Catholic Church has a close relationship with the government. However, Colombia's Constitution guarantees freedom of worship.

The arts. Advanced Indian civilizations created Colombia's earliest works of art hundreds of years ago. Gigantic stone statues of Indian gods still stand high in the Andes Mountains in southern Colombia. Bogotá's Gold Museum displays elegant jewellery, small figures, and other beautiful objects crafted by Indian goldsmiths.

Indian artistic traditions were gradually forgotten after Spanish colonists arrived in Colombia. Until the 1900's, Colombia's arts largely reflected European styles. During the mid-1900's, several Colombian artists won international recognition for their original works. They include the painters Fernando Botero and Alejandro Obregón and the sculptor Edgar Negret.

Colombians greatly admire writers, especially poets. Many Colombian lawyers, teachers, and other professionals write poetry in their spare time. *María* (1867), a novel by Jorge Isaacs, became the first work of Colombian literature to win popularity throughout Latin America. It is a sentimental tale of love and death set in rural Colombia. Colombia's most outstanding writer today,



The Andes Mountains cover most of western Colombia. Many farmers in the Andes grow coffee, Colombia's leading crop. Coffee trees thrive in the mild climate on the steep slopes, *above*.

Gabriel José García Márquez, won the Nobel Prize for literature in 1982. His tales about life in Latin America combine fantasy with realistic description.

Land

Colombia covers 1,138,000 square kilometres. There are three main land regions: (1) the Coastal Lowlands, (2) the Andes Mountains, and (3) the Eastern Plains.

The Coastal Lowlands lie along the Caribbean Sea and the Pacific Ocean.

The Caribbean Lowlands have about 20 per cent of Colombia's people and about 12 per cent of its industry. The busy Caribbean ports of Barranquilla, Cartagena, and Santa Marta handle most of Colombia's foreign trade. Beyond these cities lie banana, cotton, and sugar cane plantations; cattle ranches; and many small farms. The narrow Guajira Peninsula forms the northernmost tip of Colombia. It is a dry area with rich coal deposits. The peninsula is the home of many Guajiro Indians.

The Pacific Lowlands consist mostly of swamps and dense forests. Heavy rains fall nearly every day. Few people live in the region.

The Andes Mountains cover about a third of Colombia. They fan out from the southwestern corner of the country into three ranges—Cordillera Central, Cordillera Oriental, and Cordillera Occidental. The ranges stretch northeast across western Colombia. They include the Nevado del Ruiz, an active volcano west of Bogotá. In 1985, the volcano erupted twice and caused 25,000 deaths. The eruptions triggered floods and mud slides that buried the city of Armero and damaged other areas. An isolated range of the Andes, the Sierra Nevada de Santa Marta, rises from the Caribbean coast. It includes Colombia's highest peak, Cristóbal Colón, which rises 5,775 metres above sea level.

About three-quarters of Colombia's people live in the Andes. Rich mines, fertile farms, and large factories in valleys and basins of the Andes produce most of Colombia's wealth. Coffee trees thrive on mountain slopes in areas of mild climate. The Magdalena River separates the Cordillera Central and the Cordillera Oriental. The Cauca River separates the Cordillera Central and the Cordillera Occidental. Farmers grow various crops in the rich soil of the river valleys.



Colombia's Eastern Plains consist mainly of flat grassland, called *llanos*. Raising cattle is the chief economic activity in this sun-baked region. The cowboys *above* are rounding up cattle.

The Eastern Plains spread over nearly 60 per cent of Colombia. Only about 2 per cent of the people live in this hot, flat region. Tropical forests cover much of the south. In the north, farmers graze cattle on prairielike grassland called *llanos*. Several rivers cross the plains.

Climate

Colombia's climate varies with elevation. The highest temperatures occur in the Coastal Lowlands and the Eastern Plains. Temperatures are much lower in the snow-capped Andes Mountains. A zone of mild climate lies between 900 and 1,800 metres. Above 1,800 metres the climate is cool all year round. Few people live in the cold mountain areas above 3,000 metres.

Temperatures within a region vary little from season to season. Most of Colombia has one or two wet seasons with heavy daily rainfall each year and one or two dry seasons with little or no rainfall.

Economy

Colombia is a developing country. Its economy has long depended heavily on agriculture. Since the 1950's however, manufacturing has steadily grown in importance. Most businesses are privately owned. But the government is active in guiding the economy.

Agriculture employs slightly more than a fifth of Colombia's workers and accounts for about half of all export earnings. The country's varied climate and terrain enable farmers to grow a variety of products.

Coffee is Colombia's leading export crop by far. About an eighth of the world's trade in coffee comes from Colombia. Coffee trees grow on more than 300,000 small Colombian farms. Other major crops include bananas, cassava, cotton, maize, potatoes, rice, and sugar cane. Cattle are raised for meat, milk, and leather exports. Flowers are also an important source of income.

A small number of wealthy landholders own most of the farmland in Colombia not used to grow coffee. They hire workers or rent land to tenant farmers. Tenant farmers and many landowners work on farms that are so small that they can produce barely enough to feed their own families.

Manufacturing employs about a fifth of Colombia's workers. Most factories are in or near Bogotá, Medellín

and Cali. Many of them are small, family-operated plants. Colombia's chief manufactured products include textiles and clothing, processed foods and beverages, chemicals, metal products, and cement.

Mining accounts for only a small part of Colombia's income. But its importance is rapidly growing. Colombia has rich supplies of many minerals used in manufacturing, including coal, iron ore, petroleum, and natural gas. Colombia supplies more than 90 per cent of the world's emeralds. It is also a leading producer of gold. Large underground salt deposits supply the raw material for a thriving chemical industry.

Service industries include shops, banks, insurance firms, transportation and communication companies, and institutions that provide community services, such as schools, hospitals, and government agencies. Service industries employ about two-fifths of all Colombian workers. Many of these workers, such as salespeople and office clerks, hold low-paying jobs that require few skills.

Energy sources are abundant in Colombia. After a period when it had to import oil, Colombia became an oil-exporting nation once more in the 1980's. Colombia also has large reserves of natural gas and coal. Hydroelectric plants supply about 70 per cent of the country's electricity. Oil, gas, and coal produce the rest. In spite of Colombia's vast energy resources, some rural areas lack electricity.

Trade. Colombia's leading exports are farm products. Coffee accounts for about half of all export earnings. The government has tried to reduce Colombia's dependence on income from coffee. As a result, exports of other farm products have become increasingly important. Colombia's chief imports include petroleum and raw materials and machinery for manufacturing. The country's major trading partners include the United States, Venezuela, and Japan.



Colourful textiles rank among Colombia's leading manufactured goods. The textile industry uses cotton grown in Colombia. The factory above is in Medellín.

Authorities estimate that the smuggling of illegal drugs, such as cocaine and marijuana, from Colombia into the United States and other countries produces nearly twice the income that coffee does. However, only a few Colombians control the drug traffic and benefit from the huge sums of money brought into the country. See also the *Colombia Today* section of this article.

Transportation and communication. The Magdalena River once served as Colombia's chief transportation route. Today, a major railway and highway run along its valley. Less than 3 per cent of Colombians own a car. As a result, bus travel is popular. Bus routes link most cities. Air travel is also very important because of the rugged terrain. Airlines serve all parts of the country. Bogotá, Medellín, and Cali have major international airports.

Colombia has an average of about 1 radio for every 10 people and 1 television set for every 15 people. Colombians have great respect for the printed word. About 30 daily newspapers are published in the country. *El Espectador* and *El Tiempo* have the largest circulations. Both are independently owned and published in Bogotá, though they are sold throughout the country. Many of Colombia's political leaders, including several former presidents, have been journalists or newspaper editors.

History

Early days. Many Indian groups lived in what is now Colombia long before the first Europeans arrived. They included settled farming communities and nomadic hunting and fishing groups. The Chibcha, an advanced civilization in the Andes, traded emeralds and salt for gold and cotton with Indians along the coast.

By 1500, Spanish explorers had sailed along Colombia's Caribbean coast. The first permanent Spanish settlement in South America was founded at Santa Marta in 1525. A Spanish lawyer, Gonzalo Jiménez de Quesada, led an expedition into the Andes from 1536 to 1538 and conquered the Chibcha. In 1538, Jiménez de Quesada founded Bogotá, which he named after the Chibcha chief Bacatá. He called the surrounding area the New Kingdom of Granada because it reminded him of the region in Spain known as Granada.

Spanish rule gradually spread over the New Kingdom of Granada as Spanish colonists founded more and more towns. The colony lacked the mineral wealth of Mexico and Peru. But it produced emeralds, platinum, and some gold. Spanish settlers in the Andes forced the Indians to work in the mines and on large estates that raised cattle and grew grain. Many Indians died of overwork or of diseases brought by the Spaniards. Some Indians and Spaniards intermarried, producing the beginning of a mestizo population. Along the Caribbean coast, the Spaniards brought in black slaves from Africa to work on sugar cane and cacao plantations.

Most settlements in the New Kingdom of Granada were isolated by the rugged terrain, which made the colony difficult to unify and to govern. In 1564, the Spanish government appointed a president to govern the colony. In 1717, Spain combined the colony with neighbouring territories into one large colony called the Viceroyalty of the New Kingdom of Granada. The viceroyalty consisted of what are now Colombia, Venezuela, Ecuador, and Panama. Bogotá was the capital.

Independence. Although the New Kingdom of Granada had some able presidents, many colonists disliked Spanish rule. In 1780 and 1781, many people violently protested against new taxes. Spain crushed the revolt. But a movement for independence had begun.

Most parts of the viceroyalty declared their independence in 1810. The French army occupied Spain at that time, and Spain's South American colonies took advantage of the mother country's weakness to declare their freedom. Spain sent troops to South America after the defeat of France in 1814. Bitter fighting followed.

In 1819, the Venezuelan general Simón Bolívar defeated Spain in the Battle of Boyacá, north of Bogotá. Bolívar then became the first president of Gran Colombia, a republic made up of the territory of the former viceroyalty. The name Colombia was chosen in honour of Christopher Columbus. Gran Colombia lasted only a short time. By 1830, Venezuela and Ecuador had broken away and become separate nations.

Political disorder troubled Colombia from its start as an independent nation. Conflicts arose over how strong the central government should be and how much influence the Roman Catholic Church should have on the government. These conflicts split the country into two groups. One group supported a strong central government and a powerful role for the church. It later became the Conservative Party. The other group favoured a weak central government and strong regional governments. This group, which became the Liberal Party, also wanted to limit the role of the church.

Disputes between Colombia's Liberal and Conservative parties often erupted into violence and civil war. The country had nine Constitutions after independence, partly because each party wrote a new Constitution after taking office. The Constitution of 1853 abolished slavery. The Constitution of 1886, which established the Republic of Colombia, represented a victory for the Conservatives. It provided for a strong central government. But it did not prevent a fierce civil war, called the War of the Thousand Days, which was fought from 1899 to 1902.

The 1900's. Colombia lost Panama in 1903. That year, the Colombian Senate refused to approve a treaty that allowed the United States to build a canal across Panama. Panama then revolted against Colombia with help from the United States and quickly agreed to the canal project. In 1922, the United States paid Colombia 25 million U.S. dollars for the loss of Panama. During World War II (1939-1945), Colombia helped the United States keep the Panama Canal open.

Continuing disputes between Colombia's two major political parties reached a climax in 1948. That year, a popular Liberal Party leader, Jorge Eliécer Gaitán, was assassinated in Bogotá. Riots followed that left the centre of Bogotá in ruins and many people dead. The fighting soon spread to the countryside, where warfare and banditry continued until the mid-1960's. Colombians call this period *La Violencia* (The Violence). About 200,000 Colombians were killed during *La Violencia*.

By 1957, conditions in Colombia had become so unbearable that the Liberal and Conservative parties agreed to form a *coalition* (joint) government. Between 1958 and 1974, they shared all political offices, and the leaders of each party alternated as the nation's president every four years. The coalition, known as the National

Front, restored the people's confidence in their government and improved the economy.

Colombia today has many of the same social and economic problems that trouble other Latin American nations. A major problem is the unequal distribution of wealth. A small number of Colombians hold most of the country's wealth and political power. But large numbers of people, especially in rural areas, suffer from malnutrition, poverty, and poor education. At times, unrest among students, city workers, and rural people flares up into violent antigovernment outbursts.

Unlike many other Latin American countries, Colombia has had an elected government throughout most of its history. Today, a major government concern is to promote economic growth by curbing inflation and reducing Colombia's dependence on coffee, and developing the nation's mineral resources.

In 1985, two eruptions of the Nevado del Ruiz volcano in the central Andes west of Bogotá resulted in 25,000 deaths. They triggered floods and mudslides that buried the city of Armero and damaged other areas.

Since the mid-1980's, the government has campaigned to try to stop the country's large drug traffic. Its efforts have been met with violent resistance by the country's drug dealers. The dealers declared 'total war' against everyone involved in the campaign against their drug trade. They killed large numbers of public officials who were involved in the antidrug efforts. They also placed bombs in such places as the offices of newspapers that spoke out against the drug traffic.

Related articles in <i>World Book</i> include	
Andes Mountains	Medellín
Bogotá	Pan-American conferences
Bolívar, Simón	Panama (History)
Coffee	Panama Canal
Emerald	Santa Marta
García Márquez, Gabriel José	South America

Outline

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Questions

- After whom was Colombia named?
- What is Colombia's leading crop?
- What parts of Colombia have a chilly climate?
- What is unusual about Colombia's coastline?
- What three countries were once part of Colombia?
- Where do most of Colombia's people live?
- What is the ancestry of most Colombians?
- Why is air travel very important in Colombia?
- What was *La Violencia*?

Colombo (pop. 616,000) is the capital, seaport, and largest city of Sri Lanka. It lies on the west coast (see **Sri Lanka** [map]). Most of the island's shipping passes through its harbour. Colombo is the centre of Sri Lanka's tea, coconut, and cotton trade.

Colombo is an old city, founded before the mid-1300's. Scholars believe the city was originally known as *Kolamba*, a native term meaning both *port* and *leafy mango tree*. The name *Colombo* is the European version of this term. The Portuguese, who came in 1505, were the first Europeans to control Colombo. The Dutch occupied the city from 1656 to 1796 and erected a number of buildings that still stand. Perhaps the most impressive is the Wolfendhal Church, built in 1749. Colombo is also the home of the University of Sri Lanka. According to tradition, Buddha visited the temple of Kalaniya just outside Colombo. Commonwealth of Nations leaders set up the Colombo Plan there in 1950.

Colombo Plan provides assistance for economic development to countries of South and Southeast Asia and the Pacific. The assistance includes training personnel, scientific research in agriculture and industry, consultative services, and financial aid.

The Consultative Committee, which directs the programme, has headquarters in Colombo, Sri Lanka. It consists of representatives from the 26 member countries: Afghanistan, Australia, Bangladesh, Bhutan, Burma, Cambodia, Canada, Fiji, India, Indonesia, Iran, Japan, Laos, Malaysia, the Maldives, Nepal, New Zealand, Pakistan, Papua New Guinea, the Philippines, Singapore, South Korea, Sri Lanka, Thailand, the United Kingdom, and the United States.

The aim of the Colombo Plan is to help member countries to help themselves. The motto of the Colombo Plan is *planning prosperity together*. Member countries meet regularly to discuss development problems of various Asian and Pacific countries.

Member countries within the region plan their own development programmes with the advice of the committee. They pay most of the cost of these programmes. Member countries outside the region contribute financial assistance and cooperate in other ways. The Colombo Plan Technical Cooperation Scheme is the chief means for technical cooperation.

The Colombo Plan Bureau operates as a statistical and information centre and provides the secretariat facilities for the consultative bodies of the plan. It does not administer aid programmes. The Colombo Plan's policymaking body, the Consultative Committee, meets every two years. The Colombo Plan Council, which promotes and coordinates technical assistance in the Colombo Plan region, meets more frequently. Since 1973, the bureau has administered a Drug Advisory Programme.

History. The foreign minister of Sri Lanka, together with Sir Percy Spender, then Australia's foreign minister, proposed the idea of the Colombo Plan. They made the proposal at a meeting of Commonwealth foreign ministers at Colombo in Sri Lanka in January 1950. They called their proposal "The Colombo Plan for Co-Operative Economic Development in South and South-East Asia." This soon became shortened to the "Colombo Plan." The Consultative Committee held its first meeting in May 1950 and published the principles of the plan in Novem-

ber. The Colombo Plan began operating in July 1951.

Since 1950, membership of the plan has grown from 7 to 26 countries. In 1977, to reflect this growing membership, the organization's title was changed to "The Colombo Plan for Co-Operative Economic and Social Development in Asia and the Pacific." Financial aid given under the plan has totalled more than 45 billion Australian dollars.

Colon is a part of the large intestine. This muscular tube carries *chyme* (food residue) from the *caecum* (the first part of the large intestine) to the *rectum* (the last part). The colon is divided into four sections. The *ascending colon* extends upward on the right side of the abdominal cavity. It joins the *transverse colon*, which extends across the cavity to the opposite side. This section meets the *descending colon*, which passes down the left side and joins the S-shaped *sigmoid colon*.

In human beings, the colon is about 1.5 metres long. It removes water and mineral salts from the chyme. Its strong muscles contract and relax and so push the residue toward the rectum. Mucus that covers the colon's inner surfaces lubricates them and eases the passage of chyme.

See also **Human body** (Trans-Vision); **Colitis**; **Diverticulitis**; **Dysentery**; **Intestine**.

Colón (pop. 59,840) is the third largest city in Panama. Only Panama City and San Miguelito have more people. Colón lies in north-central Panama, at the Atlantic Ocean end of the Panama Canal. For location, see **Panama** (map).

Colón is one of Latin America's busiest commercial centres. Since 1953, it has had a *free trade zone*, where merchants can import and export goods without paying *duties* (taxes). As a result, many trading vessels carry a variety of goods to and from Colón. Merchant ships from many countries also anchor at Cristóbal, a town just south of Colón, while waiting for passage through the Panama Canal.

The main streets of Colón are often crowded with sailors, traders, and tourists. The city has many bars, nightclubs, and gambling establishments. Colón also has duty-free shops, which sell many products at low prices. Housing in Colón ranges from luxury residences to shacks in slum areas.

Colón was established as a result of the California gold rush, which began in 1849. A railway was built across Panama to transport cargo and to carry people sailing to the gold rush area from the east. Colón was founded as the railway's starting point. Its original name was Aspinwall. In 1890, the name was changed to Colón to honour Christopher Columbus, who landed near the site in 1502. *Colón* means *Columbus* in Spanish. The opening of the Panama Canal in 1914 greatly increased Colón's commerce.

Colon is a mark of punctuation shown as :. Its primary function is to separate an introduction from what it introduces: a list, a long quotation, an illustration, or an explanation. A colon is most often used when the words preceding it form a complete sentence, as in the second sentence of this article. There are two exceptions. A colon may be used to end the opening of a formal business letter, and it may be used after the main headings of an outline.

See also **Punctuation**.

Colonial life in America

Many different kinds of people lived in the 13 English colonies that became the United States. This picture shows just a few of them, including, *left to right*, an Indian, a Pilgrim, a New England farmer, a housewife, a town crier, and a Southern planter and his daughter.



Colonial life in America. The story of the American colonists is one of the great adventure tales of all time. It is the story of determined men and women who sailed across the Atlantic Ocean from Europe, conquered a wilderness, fought the native Indian inhabitants, and founded a new nation. The colonial period began with the settlement of Jamestown in 1607, and ended with the start of the American Revolution in 1775.

Most of the colonists were English. But America also attracted thousands of Dutch, French, Germans, Scots-Irish, Scots, and Swedes. The colonists brought different customs and religious beliefs but shared a common dream. All were dissatisfied with life in the Old World and wanted to make a better life in the New World.

The English were latecomers to the Americas, but they were the first Europeans to live in the New World in large numbers. England hoped to compete with other European powers for the riches of the New World. Spain had already developed a huge colonial empire in Central and South America. France came to control Canada and much of the Mississippi Valley.

The Spanish and French were interested chiefly in sending furs, gold, and other riches back to Europe. They also wanted to convert the Indians to Roman Ca-

tholicism. Their early settlements served as outposts for soldiers and traders, or as missions conducted by priests. On the other hand, the English colonies were settled by people from almost every walk of life. These people wanted to build homes in America and settle there permanently.

In making America their homeland, the colonists occasionally received help from the Indians. But most often, the Indians viewed them as invaders and fought to keep their land. The colonists, however, drove the Indians west and took the land. They produced plenty of food and other items on their farms and plantations. The colonists carried on a thriving trade with England and other countries. They built cabins, mansions, villages, and cities. They established churches, schools, and local institutions of government.

By the end of the colonial period, most colonists enjoyed living conditions equal to those of Europe's wealthiest nations. They also had more freedom to govern themselves than did any other people at that time.

This article deals entirely with the 13 original English colonies that became the United States. See also *United States, History of the* (The colonial heritage). For the history of other colonies, see *Canada, History of*.



The Thirteen Colonies

Between 1607 and 1733, the English established 13 permanent colonies on the Atlantic coast of North America. Most of the early settlements developed through business projects operated by individuals or by companies that were organized by English merchants. These people obtained permits from the king to colonize lands in the New World that he claimed belonged to him.

The English colonizers had two main goals: (1) to make profits, and (2) to expand English trade and industry. They advertised America as a land of opportunity, and persuaded many Europeans to migrate to the colonies. Many merchants provided the settlers with transportation, land, and tools.

America gave thousands of Europeans a chance to make a new start. The settlers knew they faced serious

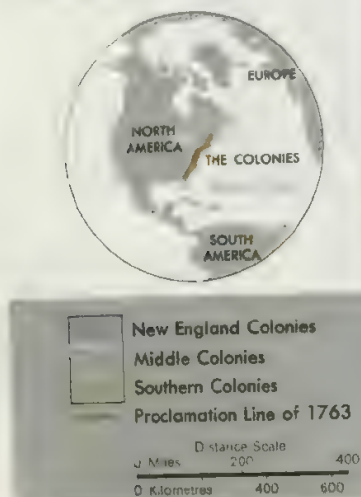
problems and would suffer severe hardships. But they had important reasons for risking the dangerous voyage across about 5,000 kilometres of ocean.

Economic opportunities. The settlers included many people who could not find work in their European homelands. Everyone could find some sort of work in America. The New World had rich land to farm and much timber to cut. Its waters and woodlands provided plenty of fish and game. These offerings were strong attractions for people who could not make a decent living in Europe.

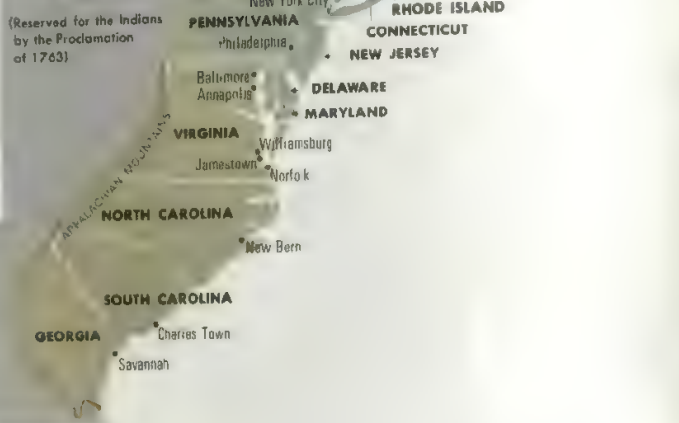
Freedom of worship. Some of the settlers, beginning with the Pilgrim Fathers, migrated chiefly because they hoped to gain freedom of worship. Throughout the colonial period, other groups headed for the colonies to escape rulers who persecuted them because of their religious beliefs. Among these groups were Quakers, Roman Catholics, Huguenots, and Jews.

The Thirteen Colonies in 1763

This map shows the 13 British colonies that became the United States. Their population grew to nearly 2 million in a little more than 150 years after a small band of Englishmen established the first permanent settlement at Jamestown.



(Reserved for the Indians by the Proclamation of 1763)



Land ownership. Many settlers came to America because they were offered land free or at low cost. In those days, owning land gave people a feeling of independence, and the promise of a good life for their children. Land ownership made a person a *freeholder*. A freeholder had certain rights in the community, generally including the right to vote. Most early settlers started as freeholders.

Early settlements. The English made an unsuccessful attempt to establish a colony in North America in 1585. That year, a group sponsored by Sir Walter Raleigh started a settlement on Roanoke Island, off the coast of what is now North Carolina. The settlers soon returned to England, and another group landed in 1587. This group disappeared mysteriously (see *Lost Colony*).

In 1606, two trading firms, the Virginia Company of London and the Virginia Company of Plymouth, were granted a colonizing charter from King James I (see *London Company*; *Plymouth Company*). Two colonies were planned: one between present-day New York and the Carolinas and one between New York and Newfoundland. Although the Virginia Company of Plymouth soon failed, the charter led to the eventual establishment of Jamestown and Plymouth. Experiences in these colonies guided future English colonization in America.

Jamestown was the first permanent English colony in America. The first known Europeans to land on what is now Jamestown Island, in Virginia, were about 100 men and boys. They came ashore on May 24, 1607 (May 14, according to the calendar then in use). The group planned to explore Virginia and trade with the Indians.

Serious problems almost ruined the colony. The area was swampy and unhealthy. About two-thirds of the original adventurers soon died of disease or starvation. More people came to Jamestown, but food was still

scarce. So many settlers died in the winter of 1609-1610 that the period became known as the "starving time."

The Europeans expected to find gold and other treasures in the wilderness, but they found none. There was nothing that they could send back to England for sale except timber products. By 1614, the settlers had learned how to grow tobacco. Exporting tobacco saved the colony by providing a way for the settlers to support themselves.

In spite of many hard times, Jamestown survived. Planters and their families replaced the explorers and traders. The Virginia Company of London also sent young women to Jamestown to marry bachelors. The Jamestown colony survived chiefly because the colonists learned how to produce their own food and supplies and because family life developed after women settled there. See *Jamestown*.

Plymouth was the second permanent English settlement in America. A group of men, women, and children who had separated from the Church of England established the colony in 1620 on the southeastern shore of what is now Massachusetts. They became known as Pilgrims because of their wanderings in search of religious freedom. They were farmers and skilled workers who wanted to raise their families where they could live according to their religious beliefs.

Although the Pilgrims were quite different from the Jamestown adventurers, they had many similar problems. The Pilgrims' poor diets helped diseases attack them during the winter, soon after they landed. Only about half the 99 Pilgrims survived the winter.

The Pilgrims had good relations with the local Indians. The Pilgrims also had the help of Squanto, an Indian who taught them how to grow maize and showed them the best fishing areas. See *Squanto*.

The story of how the Pilgrims established Plymouth Colony is one of the most famous chapters of American history. This story shows how courage and hard work can triumph over tremendous difficulties. The Pilgrims did not change their simple way of life as their colony developed. As a result, Plymouth never became prosperous. In 1691, it became part of the large colony of Massachusetts. For the story of how the Pilgrims developed their colony, see **Plymouth Colony**. See also **Pilgrims**.

Development of the colonies

After English colonists had settled Jamestown and Plymouth, large areas of the Atlantic seacoast were colonized. The later colonists suffered hardships, but there were no more "starving times" in colonial America.

The colonies are generally grouped according to location: the Northern or New England Colonies, the Middle Colonies, and the Southern Colonies. There were three major types of American colonies: (1) *royal*, (2) *proprietary*, and (3) *corporate*. A royal colony was under the direct control of the king. A proprietary colony was controlled by a prominent individual—the proprietor—under a grant from the king. A corporate colony was operated, as a rule, under a charter obtained from the king by a company's stockholders. All the 13 English colonies were founded either as proprietary or corporate colonies. By the time the American Revolution began in 1775, eight of them had become royal colonies.

The population of the colonies increased rapidly during the late 1600's and the 1700's because of both local births and a large number of immigrants. Most of the new immigrants made their homes in the Middle Colonies, though the other colonies also had many new settlers. The immigrants included large groups of Germans and Scots-Irish. Like many early settlers, they had fled hard times and religious persecution. The Germans became known as the best farmers among the colonists. The Scots-Irish won fame as the most fearsome Indian fighters.

Philadelphia was the busiest colonial port and the largest manufacturing centre of the mid-1700's. In 1760, the Philadelphia area had over 23,000 people, and by 1775 its population had grown to about 35,000. New York City had a population of about 25,000; Boston, 16,000; Charles Town, 12,000; and Newport, 11,000.

Relations with the Indians. In a few places, the Indians were friendly and helped the settlers. But in most places, tribes tried to drive the colonists out of lands that had been their hunting grounds for thousands of years. Many terrible battles occurred. See **Indian wars**.

The fighting between the colonists and the Indians became worse as settlements pushed westward. Large-scale warfare between England and France deepened the conflict. In four wars from 1689 to 1763, English and French troops in America battled each other over land claims. Eventually, France lost almost all its possessions in North America to Great Britain.

After their victory, the British recognized the claims of the Indians to the western lands that the tribes occupied. In 1763, the British issued a proclamation that prohibited colonists from settling west of the Appalachian Mountains.

Settlers who were ready to move to lands beyond the

mountains refused to obey the proclamation. Opposition by the colonists to the Proclamation of 1763 helped lead to the American Revolution (see **American Revolution**).

Colonial society consisted of several classes. At the top class were wealthy merchants and planters, and their families. They were called the "gentry" or the "better sort." They lived in mansions and most often travelled in comfortable carriages. Some of the gentry were also well educated. They included ministers, lawyers, and doctors.

Below the gentry were members of the "middling sort." Most of them were farmers or shopkeepers who owned property but were not wealthy. This class also included craftworkers. The next lowest rank was called the "lower sort" or the "meaner sort." It consisted of poor people, such as unskilled labourers. At the bottom of society were people who lacked freedom, such as slaves and *indentured servants*. An indentured servant was a person who came to the colonies under a contract to work for a master without wages. Instead of paying wages, the master paid for the servant's passage from Europe. The servant also received food, clothing, and housing. Contracts usually covered four years.

Only slaves were forced to spend their lives at the lowest level of society. Most slaves had no rights. Slaves were blacks, originally brought from Africa against their will and sold to planters. Most slaves lived in the Southern Colonies and worked as field hands, skilled plantation labourers, or house servants.

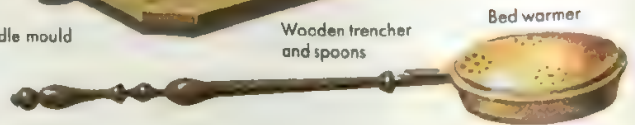
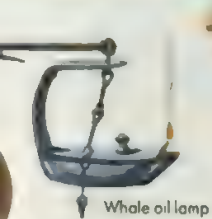
Government. Each colony had a governor and a legislature. The king of England appointed the governor of royal colonies. In proprietary colonies, the proprietor named the governor. In Connecticut and Rhode Island, the people elected the governor. All the colonial legislatures except Pennsylvania's *unicameral* (one-house) system consisted of two houses, and resembled the English Parliament in structure.

Voting requirements differed in the various colonies, and changed from time to time. One of the most important requirements was property ownership. By 1750, most white adult male citizens who owned property could vote. Other possessions could be substituted for property.

Local government in the colonies was based on English county and town governments. In the Southern Colonies, the county court conducted most public business. This court consisted of justices of the peace, appointed by the governor. The justices tried certain civil and criminal cases. They also levied taxes, supervised road construction and ferry service, and organized the *militia* (citizen soldiers). In New England, the courts only dealt with matters of law.

Law enforcement in the colonies was the job of constables and sheriffs. Persons accused of a crime punishable by death were tried by certain high courts. Death by hanging was the customary penalty for armed robbery, counterfeiting, murder, piracy, or treason.

Local courts with juries tried persons accused of such minor offences as drunkenness, slander, swearing, theft, disturbing the peace, or breaking the Sabbath. Punishments included fines, public whipping, and suffering disgrace with the pillory, stocks, or ducking stool (see **Ducking stool**; **Pillory**; **Stocks**).



Farmhouse

Every member of the family shared in the tasks of a colonial household. The early settlers made most of their own clothing, furniture, and cooking utensils. In farmhouses throughout the colonies, the family gathered at nightfall to work in the light and warmth of the fireplace.

Everyday life in the colonies

Colonial households were large. Some of them included grandparents, aunts, uncles, and cousins living together in one home. Servants and slaves also belonged to the extended family group. All members of the group worked together to support the household.

Houses. The first settlers built houses that closely resembled those they had known in Europe. The colonists later changed their housing styles so they could make the best use of local building materials. The first cottages of Jamestown and Plymouth had thatched roofs, like English cottages. After the colonists found wood more plentiful than reeds or straw, wood shingles replaced thatch.

Many wealthy colonial merchants and planters built

homes in a style called Georgian architecture. Most Georgian houses were square or rectangular, with a central stair hall and many tall windows. The front door was large and impressive, and the main rooms had fine wood panelling. See **Georgian architecture**.

The mansion of a typical southern plantation stood on a hill and overlooked a bay or river. It was surrounded by gardens, orchards, and shade trees, with a kitchen, laundry, and *smokehouse* (a place where meat or fish were cured by dense smoke) nearby. Farther away were the stables and carriage house, and cabins where the slaves lived.

Furnishings of the first settlers were homemade, except for a few possessions brought from Europe. Many families made most of their own furniture and other household articles throughout the colonial period.

Wealthy colonists imported their furnishings, generally from England.

Food was plentiful during most of the colonial period. After the first few years, the colonists kept themselves better supplied with food than any other people in the world. On their farms they grew grain, fruits, and vegetables, and raised cattle, pigs, sheep, chickens. They hunted deer, pigeons, squirrels, wild turkeys, and other game. From the river and ocean waters, they took clams, oysters, lobsters, and many kinds of fish. Maize was a basic food in almost every household.

The colonists had difficulty storing food for the winter because they had no methods of canning or refrigeration. They salted or smoked some meats, and dried or

pickled certain vegetables. Root vegetables, and such fruits as apples or pears, were kept in cool, dry cellars. As a rule, the colonists depended on bread and meat for their food during the winter.

Health of the colonists was poor by today's standards. Contagious diseases sometimes spread rapidly and took many lives in the colonies. The settlers suffered epidemics of such diseases as measles, smallpox, diphtheria, typhoid fever, scarlet fever, and yellow fever. Other widespread illnesses included dysentery, gout, influenza, pneumonia, rheumatism, scurvy, and tuberculosis.

Most colonists took medicines made of certain barks, herbs, or roots. These medicines, although believed to be powerful cures, usually failed. One helpful medicine was quinine, a bitter substance taken from the bark of the cinchona tree. The colonists used it for a common malarial fever called ague. Doctors still use quinine to treat certain types of malaria. Popular medicines were made from tobacco leaves and the roots of the ginseng plant and the sassafras tree.

The church strongly influenced the social and political life of colonial times. Most of the colonists were deeply religious. Many had come to America chiefly so they could worship according to their beliefs. In Europe, many religious groups had been persecuted for trying to establish new forms of worship.

Most colonial religious groups dated from the 1500s. They developed during the Reformation, a religious movement in Europe that resulted in the birth of Protestantism.

In most of the colonies, church officials performed important public services which today are generally the work of government agencies. They supervised education and care of the poor, and kept records of baptisms, marriages, and deaths. The people used their church building not only as a place of worship, but also for community gatherings.

A series of religious revivals, known as the Great Awakening, spread through the colonies in the early 1700s. Travelling preachers called *evangelists* held revival meetings in churches and open fields. But certain ministers of established churches opposed many of the evangelistic ideas. They feared that strong ideas about equality might weaken their power to make church rules. In spite of such opposition, a new interest developed in the importance of the common person in society.

The school. The children of well-to-do colonists attended private schools or were educated by private teachers called tutors. The colonists established some state schools, but most children from poor families were taught by their parents at home. Some parents did not know how to read or write, so they could not teach those skills.

Most parents taught their children obedience, religious beliefs, and the skills they would need in their daily lives. Boys learned how to farm, raise cattle, and handle a gun. Girls learned such household tasks as sewing, spinning, and weaving, and how to cook and preserve food.

The first state school system supported by taxes was set up in New England in 1647. That year, a Massachusetts law called for every town with at least 50 families



Detail from the frontispiece to Dilworth's *New Guide to the English Tongue*. Folger Shakespeare Library, Washington, D.C., U.S.A.

Children's games in colonial times included many that are still popular. The youngsters shot marbles, flew kites, and played hopscotch, leapfrog, prisoners' base, and blindman's buff.



From *Alle de Wercken*, 1657-59, by Jacob Cats. Folger Shakespeare Library, Washington, D.C., U.S.A.

Shearing sheep and cutting bristles from pigs supplied materials for many colonial household items. The sheep's wool was spun into yarn, and the pig's bristles were used in brushes.

to establish a primary school. Larger towns were expected to establish a secondary school, called a grammar school. But parents could still teach their children at home, and the wealthy could send theirs to private schools.

Travel. Most of the early colonists rarely travelled far from home. As a rule, long journeys were made only by traders, or wealthy merchants or planters. These people generally travelled for business or pleasure by boat on rivers, bays, and the coastal waters. Freight and passengers were carried in many types of sailing vessels, including brigantines, schooners, shallops, sloops, and yawls. Large ships that sailed across the ocean carried small boats which could be put over the side for travel on shallow inland waters.

Land transportation was slow and difficult. The first colonial roads were merely paths that followed ancient Indian trails through the woodlands. The colonists widened the paths for travel on horseback, and later for carts or wagons pulled by horses or oxen. Ferries carried travellers across rivers. Most of the wooden bridges built by the colonists could be used only by foot travellers, not by vehicles. By 1760, Philadelphia had two stone bridges.

By the mid-1700s, comfortable passenger vehicles were being used in the towns by government officials and wealthy colonists. These vehicles included carriages, chariots, and coaches, drawn by four, six, or eight horses; two-horse chaises, curricles, and phaetons; and one-horse "riding chairs." Many carriages had richly carved wooden sides, and seats upholstered in leather or brightly coloured cloth. Brass or silver ornaments decorated the harnesses.

A town crier read news to the townsfolk until newspapers came into general use in the mid-1700s.

Colonial stagecoaches began operating in the mid-1700s. Taverns provided food and lodging along the way.

Communication. During the 1600's, the colonists exchanged news chiefly by word of mouth. Someone would learn about an event from a peddler or a ship's captain, and repeat the story to his neighbours. Friends exchanged news in letters that they often gave to travellers to deliver.

News was also spread by *postriders*, the first colonial mail deliverers. A postrider carried letters or messages, travelling on horseback along a certain route called a post road. On the way, the postrider picked up news and passed it on to individuals at such stopping places as post offices and taverns. In most towns, a town crier read news to the people.

Mail service operated irregularly in colonial times. Until 1700, it existed only in Massachusetts, New York, and Pennsylvania. In 1753, Benjamin Franklin of Pennsylvania and William Hunter of Virginia were appointed to manage the colonial postal service. Under their direction, post offices were established in all the colonies, and service improved greatly.

Newspapers came into general use after the mid-1700s. The first successful American newspaper, *The Boston News-Letter*, had started publication in 1704. During the next 60 years, newspapers were published in every colony except Delaware and New Jersey.



Engraving of an old Pennsylvania Inn by E. T. Scowcroft. Free Library of Philadelphia, U.S.A.



Arts and sciences

The task of building homes and communities in a rugged land demanded great energy and effort. As a result, the early American colonists had little time for the arts or sciences. In 1743, Benjamin Franklin wrote that "the first drudgery of settling new colonies" was completed and there could be "leisure to cultivate the finer arts and improve the common stock of knowledge." By the end of the colonial period, some colonists had made important contributions to literature and painting. Other colonists were active in such scientific fields as astronomy and botany.

Literature. The earliest descriptions of colonial life were written to tell Europeans about the settlements in the New World. John Smith wrote about Jamestown and New England, William Bradford described the Plymouth Colony, and John Winthrop told of the Massachusetts Bay Colony.

Religious writings made up the bulk of colonial literature published in America during the 1600's. The first book printed in the colonies was a collection of psalms, published in 1640. Several ministers prepared this book, which became known as the *Bay Psalm Book*. Three religious leaders—Jonathan Edwards, Cotton Mather, and John Woolman—wrote many books and pamphlets during the 1700's. See *Bay Psalm Book*.

Colonial poets also dealt chiefly with religious subjects. Michael Wigglesworth, a New England poet, wrote *Day of Doom*, the most popular literary work of the time. Anne Dudley Bradstreet, another New Englander, became America's first woman poet. She is best known for her collected poems, *The Tenth Muse Lately Sprung Up in America*.

Writings on political subjects became important during the mid-1700's. Dozens of revolutionary pamphlets and poems were circulated after Great Britain passed the Stamp Act of 1765 (see *Stamp Act*). Benjamin Franklin was one of the most influential political writers, but he did not limit himself to politics. Franklin's witty proverbs helped make his *Poor Richard's Almanac* a favourite publication of the colonists. For a detailed account of

colonial writers and their works, see the *World Book* article *American literature*.

Painting. During the mid-1700's, several young colonists were trained by visiting European artists. These American artists, who went to Europe for further study and became world famous, included John Singleton Copley, Charles Willson Peale, Gilbert Charles Stuart, and Benjamin West.

Earlier American artists, called *limners*, had little formal training. They travelled throughout the colonies and earned a living by painting portraits of wealthy colonists. Well-known colonial limners included Charles Bridges, Gustavus Hesselius, Henrietta Johnston, John Smibert, and Jeremiah Theüs.

Science. During most of the colonial period, educated people had broad scientific interests. Many of them worked to improve education and expand scientific study in the New World.

Benjamin Franklin won honours throughout the world for his scientific experiments and inventions. He led all the people of his day in the study of electricity. In 1752, Franklin flew a homemade kite during a thunderstorm and proved that lightning is electricity. Then he invented the lightning rod, a way to tame electricity. See *Franklin, Benjamin (Scientist)*.

Franklin also encouraged other scientists. In 1727, he formed the Junto, a debating club. Most of the members were interested in science as well as politics. They met regularly in Philadelphia to exchange ideas. In 1743, Franklin founded the American Philosophical Society. This organization became the chief centre of colonial science.

John Bartram was the most famous botanist of the period. In 1728, he planted America's first botanical garden. Other noted colonial botanists included John Banister, John Clayton, Cadwallader Colden, John Mitchell, and Alexander Garden, after whom the gardenia was named.

Colonial scientists of the 1700's were well informed about new discoveries in astronomy, chemistry, meteorology, and physics. They often exchanged ideas with European scientists. Many performed laboratory experi-



Baptismal Certificate by Heinrich Otto. Free Library of Philadelphia, U.S.A.

Documentary script, surrounded by floral designs in colour, was developed as an art by a number of German colonists.



Colonial architecture has been preserved in the stately Governor's Palace reconstructed in Williamsburg, Virginia.



Planting maize for food, a skill learned from the Indians, saved many early settlers from starvation.

The homemade plough, below left, and the ancient **mattock**, below right, were important colonial farm tools.



The cradle scythe came into common use during the mid-1700's for harvesting grain on colonial farms.



The wedge-shaped iron froe, a basic colonial tool, was often used to split logs into the slabs that made a sturdy table.



ments or kept records of rainfall, temperature, and the appearance of comets.

Economy

Throughout the colonial period, farming was the most important way of making a living. Farming meant survival for the first settlers. To stay alive, they had to produce food, along with materials for clothing and shelter. As their settlements grew, the colonists produced grains, tobacco, livestock, and other farm products for export.

The colonists also developed such industries as fishing and whaling, logging, shipbuilding, ironmaking, rum distilling, and flour milling. Colonial craftworkers made furniture, glassware, pottery, and metalware of pewter, iron, or silver.

Farming. Most colonial farmers were successful because they worked hard and land was plentiful. By today's standards, colonial farming methods were wasteful. The colonists usually planted the same kind of crop repeatedly, and the soil became exhausted after a few harvests. Then the farmers simply cleared more land. The most skilful farmers were the German settlers who rotated their crops and added fertilizers to the soil. These methods kept their land highly productive.

The colonial farmer worked mostly with hand tools, including an axe, hoe, scythe, sickle, and spade. He also had a *mattock*, a kind of pickaxe with flat blades. The farmer used a mattock to break up soil or cut roots. These tools were not much better than the sharpened sticks used by the Indians.

In spite of wasteful methods and poor tools, the colonial farmer was as prosperous as any farmer of the day, anywhere in the world. Even in New England, with its rocky land and short growing season, farmers were well-off. They produced enough vegetables, grain, and meat to feed their families, and sold any surplus.

Maize was the most important crop of early colonial times. The Indians showed the first settlers how to plant and cultivate it, and how to grind the kernels to make maize meal. Farmers in all the colonies grew maize. As colonial farming developed, wheat replaced maize as the chief grain. But farmers continued to grow large crops of maize to feed their livestock.

Wheat was the most valuable crop of the Middle Colonies. There, a farmer had the advantage of excellent soil and a highly favourable climate.

Many Maryland and Virginia planters specialized in growing tobacco. But by the 1700's, they also started growing food crops, including maize and wheat, for export.

The farmers of Georgia and South Carolina developed two important crops—rice and indigo. About 1724 the South Carolina rice growers introduced irrigation systems, which increased the size of their crops. The indigo plant was the chief source of a blue dye.

The Southern Colonies grew some cotton, but this crop did not become important until after the American Revolution. Some farmers in Pennsylvania and Virginia began to grow flax and hemp about 1750.

Trade and industry. Colonial trade centred on the exchange of raw materials for European goods. English merchants were the chief customers of the colonists, and manufactured goods were the main imports.

Trade of the colonists was strongly influenced by England's economic system, called *mercantilism*. Under this system, the English government protected the nation's industries against competition from the industries of other countries. A basic principle of mercantilism was governmental control of colonial trade. Parliament tried to strengthen that control by passing a series of laws called the *Navigation Acts*. See *Mercantilism; Navigation Acts*. The colonists got around the restrictions by developing trade routes that linked colonial ports with southern Europe, the West Indies, and Africa. These routes became known as the "triangular trade routes."

Fishing and whaling became major industries in New England for two important reasons. First, the rocky New England land was not suitable for growing large crops. Second, New England ports were within easy sailing distance of the finest fishing and whaling waters of North America. These Atlantic coastal waters included the famous fishing area of the Grand Banks, off Newfoundland.

From the time of the first settlements, logging was an important activity in all the colonies. Timber products ranked among the chief exports of the colonists. The first export from Jamestown consisted of a cargo of clapboard and other building materials shipped to England in 1608. New England was the centre of the shipbuilding industry, largely because of the demand there for fishing boats and merchant ships.

Iron ore, the most important ore found by the settlers, was mined in most of the colonies. The colonists obtained charcoal, the chief fuel used to smelt iron ore, from their large supplies of hardwoods.

The colonies exported much iron to England in the form of iron bars. But the colonists themselves provided the most important market of the ironmaking industry. Every village had a blacksmith shop where smiths hammered out iron nails, hoes, and other farm tools. Ironworks also manufactured these items, along with such products as kettles, wagon components, and wire.

The English government did not allow the colonists to mint coins. But Massachusetts built a mint anyway, and from 1652 to 1682 made various silver coins, including pine-tree shillings (see *Pine-tree shilling*). Massachusetts and the other colonies sometimes were permitted to issue paper money.

Crafts. During the early colonial period, most of the settlers made their own furniture and household articles. Wealthy colonists generally imported their furnishings from England. Later, skilled colonial craftworkers made many products of wood, iron, silver, pewter, glass, or leather. Some workers copied European styles, but others developed a special American style.

Most craftworkers had shops in the cities or towns. In New England, some of them travelled from one community to another. Many customers supplied them with the raw materials needed for their work. Examples of colonial crafts may be seen today in many museums.

Related articles in *World Book* include:

Colonization

Dutch West India Company	New England, Dominion of
Jamestown	New England Confederation
London Company	New Netherland
Lost Colony	New Sweden
Massachusetts Bay Colony	

Biographies

Alden (John; Priscilla Mullens)	Phillip, King
Andros, Sir Edmund	Rolfe, John
Bacon, Nathaniel	Samoset
Baltimore, Lord	Smith, John
Berkeley, Sir William	Squanto
Byrd, William	Standish, Miles
Cotton, John	Stuyvesant, Peter
Dare, Virginia	Van Rensselaer, Kiliaen
Faneuil, Peter	White, Peregrine
Franklin, Benjamin	Williams, Roger
Hutchinson, Anne M.	Winslow, Edward
Mather (family)	Winthrop, John
Minuit, Peter	Winthrop, John Jr
Oglethorpe, James E.	Wise, John
Penn, William	Zenger, John Peter

Other related articles

American literature	Pennsylvania Dutch
Bay Psalm Book	Pilgrim Fathers
Charter Oak	Puritans
Hornbook	Salem witchcraft trials
House of Burgesses	Shot tower
Indentured servant	Slavery (Slavery in the United States)
Indian wars	Witchcraft
Mayflower	
Mayflower Compact	

Outline

I. The Thirteen Colonies

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- C. Science

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- C. Crafts

Questions

How did English colonists differ from the Spanish and the French settlers?

Why did the Pilgrim Fathers migrate to America?

What was the chief reason for the Jamestown colony's survival?

What were the three major types of colonies?

What was the purpose of the Proclamation of 1763?

What was an indentured servant?

What were the duties of a justice of the peace in a southern colony?

How did Benjamin Franklin encourage scientists in the colonies?

What was the specialist crop grown in Maryland and Virginia?

What were the major industries in New England?

Colonialism is a term that usually refers to the rule of a group of people by a foreign power. The people and their land make up a colony. Most colonies are separated by an ocean from the ruling nation. The foreign power sends members of its people to live in the colony, to govern it, and to use it as a source of wealth. The rulers and the local people usually belong to different ethnic groups.

Colonialism dates back to ancient times. The Romans ruled many colonies in Europe, the Middle East, and Africa. Beginning in the A.D. 1400's, European nations built vast colonial empires in Africa, Asia, North America, and

South America. The major colonial powers of Europe were France, Great Britain, the Netherlands, Portugal, and Spain. By the 1970's, most colonial empires had broken up.

Nations have sought colonies chiefly to gain economic benefits. They have wanted land and such valuable products as diamonds, gold, and spices for themselves. They also have wanted to expand their industry and trade by gaining (1) sources of raw materials, (2) markets for their goods, (3) sources of goods that could be exported to other countries, and (4) opportunities for investment. In addition, nations have practised colonialism to increase their reputation among other nations, to gain military advantages, and to spread their religion.

Some people believe that widespread colonialism still exists. They define colonialism as any form of economic, political, or social *oppression* (unjust treatment) of one group by a group of different ancestry. However, this definition is not widely accepted. Other people use the term *neocolonialism* for the indirect control they believe is exercised by developed nations over developing nations. According to these people, many developing nations depend on investment capital from developed nations. Dependence of this kind supposedly allows the developed nations to take advantage of the developing ones.

History of colonialism

Ancient colonialism. The Roman Empire was the greatest colonial empire of ancient times. Rome began its overseas expansion about 264 B.C. At its height, the Roman Empire extended from northern Britain to the Red Sea and Persian Gulf. The empire collapsed in A.D. 476.

Early European colonialism. In the 1400's, Portugal and Spain began to send explorers in search of sea routes to India and the Far East. Muslims controlled land routes across the Middle East and so controlled trade between Asia and Europe. Europeans hoped to take over this trade. Portugal gained control of Brazil and established trading posts in West Africa, India, and Southeast Asia. Spain gained control of part of what is now the United States and also took control of many parts of Latin America.

During the 1600's, the Dutch and the English took control of the Asian trade from the Portuguese. The Dutch gained control of the islands that became the Dutch East Indies (now Indonesia), and the English became a strong influence in India. The Dutch, English, and French also took over parts of Latin America.

The English and French moved into parts of Canada as well. The Dutch, English, and French claimed sections of what became the United States. There, the English eventually established the Thirteen Colonies. The four French and Indian wars between the British and the French took place in North America from 1689 to 1763. The last of these wars ended in a British victory, and Great Britain took control of most of France's North American possessions.

Later colonialism. The Thirteen Colonies gained independence from England in the American Revolution (1775-1783). Most colonies in Latin America fought for and won independence in the 1700's and early 1800's.

European colonial expansion slowed somewhat dur-

ing the early and mid-1800's, though Great Britain claimed several colonies in Australia. The first colony to be established in Australia had been New South Wales in the late 1700's. Many of the earliest settlers were convicts, transported to Australia as punishment. Transportation was abolished in the mid-1800's and by that time colonies had been established in Queensland, Van Diemen's Land (now Tasmania), Western Australia, South Australia, and Victoria. New Zealand was made a British colony in 1840. By the 1850's many people had come to believe that colonies were not worth the trouble and expense involved in managing them. However, the Industrial Revolution and the rise of European nationalism contributed to great colonial expansion during the late 1800's and early 1900's in Africa and Asia. On those two continents, the industrial nations sought raw materials for their factories, markets for their manufactured goods, and opportunities for investment. They also sought territories that would improve their position against European rivals.

Belgium, France, Germany, Great Britain, Italy, Portugal, and Spain took most of Africa, leaving only Ethiopia and Liberia independent. Great Britain extended its control in India, Burma, and what is now Malaysia. The French took over Indochina. French Indochina consisted of Kampuchea (Cambodia), Laos, and Vietnam. The Dutch expanded their control in the East Indies. The United States acquired the Philippines. France, Germany, Great Britain, Spain, and the United States competed for control of the Pacific Islands.

Also in the late 1800's and early 1900's, conquests gave Japan an empire that included Korea and Taiwan. During World War II (1939-1945), Japan added to its empire by conquering a number of colonies formerly held by Western nations. The empire collapsed after Japan was defeated in 1945. Most of the colonies were returned to the Western nations.

Three factors helped bring large-scale colonialism to an end during the 1950's and 1960's. First, the European nations had been weakened by the war. In addition, many people had come to oppose colonialism as unjust. Finally, nationalist feelings and demands for self-government had been growing among most colonies in Africa and Asia. Some of these colonies gained independence peacefully. Others became independent only after fighting a war against their ruler. Portugal kept control over its African colonies until the mid-1970's, when it granted them independence.

Colonialism today. France, Great Britain, Portugal, Spain, and other nations still govern a few overseas areas. However, most nations do not officially call such areas *colonies*. Great Britain, for example, calls them *dependencies*. The United States governs a number of overseas areas, including American Samoa, Guam, and various other Pacific islands; Puerto Rico; and the Virgin Islands.

Colonial policies

Many colonial rulers forced their way of life on the people of their colonies. They did so partly because they considered the culture of the colonial people inferior to their own. Many rulers tried to convert the colonial people to their own religion. They also made their own language the official language of the colonies. In many

cases, colonial rulers tried to replace the native culture with their own culture. Most colonial rulers helped make the colonies more modern by building railways, roads, and factories and by setting up schools and hospitals. But the colonial powers were chiefly concerned with establishing economic and political policies that would be most beneficial to themselves.

Economic policies. Ruling nations sought economic benefits from their colonies. In ancient times, such nations increased their wealth by forcing conquered peoples to work for them and to make payments in return for protection from other nations. These payments were called *tribute*.

From the 1400's to the 1700's, an economic system called *mercantilism* existed in Europe. Under this system, the European powers moulded the economy of their colonies to fit their own trading needs. For example, Britain passed a series of laws during the 1600's and 1700's to strengthen its control over the economy of the Thirteen Colonies, its colonies in North America. Some of these laws required the American colonists to trade almost entirely with merchants in Great Britain or in other British colonies, and to use British ships. Other laws limited colonial manufacturing because the British wanted the colonists to depend largely on Great Britain for manufactured goods. To encourage the Americans to export goods needed by Great Britain, the British granted certain trading privileges to such exports. Other European nations handled trade with their colonies in a similar way.

Slavery was an important part of colonial economic policies during the mercantilist period. In the South American colonies, the Europeans first forced the native Indians to work on the plantations that produced cotton and other raw materials. Later, they imported slaves from Africa.

Most countries in North and South America abolished slavery during the 1800's. About the mid-1800's, the British decided that mercantilism had hurt some of their industries. As a result, Great Britain gradually adopted a system of *free trade*, which eventually ended controls on colonial trade. By 1870, most other colonial powers also had removed controls from their trading practices.

Free trade did not prevent the expansion of colonialism in Africa and Asia. Colonies still could provide raw materials and markets for European goods. Also, European bankers and industrialists made profits by investing in the factories, mines, plantations, and railways being created in so-called "backward" regions. The European nations established colonies in these regions partly to protect such investments.

By the early 1900's, most colonial powers had again adopted a system of economic controls. However, these controls were not nearly so restrictive as those of the mercantilist period. Today, most colonies have close economic ties with the nation that rules them.

Political policies used in governing colonies varied widely. Some ruling nations made their colonies completely dependent. Others allowed them some self-government. The colonial rule of Belgium, France, Great Britain, and Portugal in Africa and Asia shows how political policies differed.

Belgium's chief colony was the Belgian Congo (now

Zaire) in Africa. Belgium gained control of the Congo in 1885 and ruled it entirely from Brussels, the Belgian capital. The Belgians gave the Congolese no share in the government. Uprisings occurred in the Congo in 1959, and Belgium granted independence in 1960.

Likewise, the French governed their colonies completely from Paris. The people of the upper class in the colonies were expected to become like the French—culturally, economically, and politically. Two colonial revolts showed the unwillingness of the French to accept the end of colonialism. A revolt against French rule began in Indochina in 1946 and did not end until 1954, when the French withdrew after suffering heavy losses. Also in 1954, a revolution broke out in Algeria, a French territory in Africa.

The fighting there continued until 1962, when Algeria became independent. France has peacefully granted independence to most of its other possessions.

Great Britain at first governed its colonies largely through British officials. But through the years, the British gave colonials a growing role in local courts, legislative councils, and public service. For example, the people of India played an increasing part in their government from 1918 to 1939, the period between World War I and World War II. India gained independence from Great Britain in 1947. Its successful change from colony to nation led Britain to grant independence to other colonies.

Portugal claimed that its colonies were self-governing. However, Portugal determined most major legislation and administrative policy for the overseas provinces.

Effects of colonialism

Colonialism has had both good and bad effects on colonies and ruling nations. Rulers did bring some economic development to their colonies by introducing Western agricultural, industrial, and medical techniques. At the same time, however, the colonial powers often *exploited* (took advantage of) their colonies economically. In many colonies, the ruling powers disrupted and transformed the traditional economic structure. They limited the colonies to producing mainly raw materials and to buying most of their manufactured goods from the ruling countries. In this way, they destroyed the colonies' commercial and manufacturing activities. Although there were advantages for the colonies in becoming part of a worldwide economic system, the people of the colonies lost control over their economic activities. In addition, higher living standards and peace led to great population increases that sometimes kept those standards from improving further—or even lowered them.

Colonial rule brought many people under the political control of European nations. But it also ended local wars in many areas and united those areas under one nation. Ruling powers set up modern educational systems and introduced democratic forms of government. Yet in many cases, the rulers gave the colonial people too little training to prepare them for independence. Many rulers also tried to force their culture on colonial people. Many historians believe that knowledge of Western culture benefited colonial peoples in various ways. However, after gaining independence, many for-

mer colonies have had to struggle to redefine their cultural identity.

Colonialism brought wealth and power to the ruling nations. But it also led to nationalist feelings and resistance movements among colonial peoples—and thus helped bring about its own end.

One unexpected result of the end of colonialism has been the migration of many people from former colonies to the countries that once ruled them. Large numbers of Indians, Pakistanis, and West Indians have gone to Great Britain. Many people from Indonesia and Suriname have moved to the Netherlands. A large number of North Africans now live in France. This migration has created ethnic diversity in European nations that once had unmixed populations.

Related articles in *World Book*. See the *History* section of the articles on countries mentioned in this article. See also the following articles:

Africa (History)	Mercantilism
Asia (History)	Minority group
Colony	Protectorate
Commonwealth of Nations	Rome, Ancient
East India Company	Territory
Enclave	Trust territory
Exploration	United Kingdom, History of the
Governor general	United States, History of the
Imperialism	World, History of the
Mandated territory	

Colony. See *Animal* (Animal homes; Animals that live together); *Ant* (Life in an ant colony); *Bee* (The honey bee colony); *Beaver*; *Portuguese man-of-war*.

Colony is a settlement established by people outside their native land, and ruled by the mother country. Nations establish colonies to find more room in which people can live, to increase trade by providing a market for manufactured goods, to gain sources of raw materials, to secure military advantages, and to increase the prestige of the mother country.

Almost half the members of the United Nations are former colonies that have become independent since World War II (1939-1945).

See also *Colonialism* and its list of *Related articles*.

Colony, Penal. See *Penal colony*.

Colophon. See *Book* (Inside a book).

Color. See *Colour*.

Colorado is a state in the Rocky Mountain region of the western United States. It is the centre of finance, manufacturing, and trade in the Rocky Mountain states. Much of the state's economic activity is concentrated in and around Denver, the capital and largest city. Each winter, Colorado ski resorts attract thousands of visitors.

Mining has played an important part in Colorado's economy and history. A series of mining booms there has sparked growth since the 1800's, when gold and silver mining brought wealth to the area. Petroleum became the state's most important mineral product.

Land. The Colorado Plateau, along the western border, covers about a fifth of the state. It is an area of high hills, plateaus (wide, raised sections of land), deep valleys, and mesas (flat-topped, steep-sided land elevations). The *Intermontane Basin*, north of the plateau, is a small region of forested hills and sagebrush plateaus.

The Rocky Mountains cover the middle two-fifths of Colorado. The Colorado Rockies have the highest peaks in the Rocky Mountain chain, which stretches from



Unusual rock formations stand in the Colorado National Monument. They make up part of the Colorado Plateau, a region of high hills and deep valleys in western Colorado.

Alaska to New Mexico. The *Continental Divide* runs through the Colorado Rockies; streams east of the divide flow into the Atlantic Ocean, those west of it into the Pacific. The Great Plains cover roughly the eastern two-fifths of Colorado.

Economy. Wholesale and retail trade is Colorado's largest employer. The wholesale trade of motor vehicles and mineral products is especially important. Shops, restaurants, and other retail businesses provide much income in Colorado's cities.

Denver is a major financial centre in the western United States. Several major U.S. banks and insurance companies have large branch offices in Denver.

The government employs many Colorado workers in schools and military establishments. The U.S. Air Force has several large facilities near Colorado Springs.

Goods manufactured in Colorado include scientific instruments, food products, and aerospace equipment.

Facts in brief

Population: 3,307,912.

Area: 269,595 km².

Climate: Average July temperature 23° C. Average January temperature -2° C.

Elevation: Highest—Mount Elbert 4,399 m. Lowest—1,021 m.

Largest cities: Denver, Colorado Springs, Aurora, Lakewood

Chief products: *Agriculture*—beef cattle, wheat, corn, milk, hay. *Manufacturing*—food products, scientific instruments, machinery, printed materials, transportation equipment, electrical equipment. *Mining*—coal, petroleum, natural gas.

Origin of name: Spanish word for *coloured red*. (The Colorado River flows through canyons of red stone.)

Nickname: Centennial State.

Statehood: Aug. 1, 1876 (the centennial year of the U.S. Declaration of Independence), the 38th state.



Denver, Colorado's capital and largest city, boasts a spectacular view of the Rocky Mountains, which lie just west of the city

Cattle ranching is the leading farm activity. Colorado's chief mineral products are oil, coal, and natural gas.

History. Indians lived in Colorado before Spanish explorers arrived in the 1600's. In 1706, Juan de Ulibarri, a Spaniard, claimed the region for Spain.

In 1803, the United States bought a portion of the area. Mexico won control of western Colorado from Spain in 1821. The U.S. wrested control from Mexico during the Mexican War (1846-1848). Colorado had few settlers until the discovery of gold in the late 1850's. The U.S. Congress created the Colorado territory in 1861.

Indians and whites clashed often during the 1860's and 1870's. Colorado became a state of the U.S.A. on Aug. 1, 1876. By 1910, agriculture had replaced mining as the most important industry.

The development of motor cars in the early 1900's boosted Colorado's oil and tourism industries. The state's population increased after World War II (1939-1945), and Colorado's need for flood control, irrigation, and water storage became severe. Several large water management projects were later developed.

By 1954, manufacturing had replaced agriculture as the leading industry. The Denver area later became a centre for energy-related activities.

See also **Denver**.



Colorado is a large state in the Rocky Mountain region of the United States.

Colorado beetle, also called *Colorado potato beetle*, is a stout yellow beetle and the most destructive of the insect pests that attack the potato plant. It is about 13 millimetres long and may be recognized by its wing covers, each of which has five black stripes. It is said to have originated in Mexico, but gets its common name from where it was found—the area where the Colorado River cuts through the Rocky Mountains, in the United States. When potatoes were first grown in western U.S.A., the beetle spread from its original food plant, the buffalo bur, and travelled from field to field, living on potato plants. By 1875, it had spread to the Atlantic.

The beetle reached Europe in 1921, when it appeared in southwest France. It has since spread in all directions and has caused great damage in many countries, including Greece, Poland, and the former Soviet Union.



The **Colorado beetle**, above, deposits its eggs on potato plants in the spring. The larvae then feed on the tender leaves, damaging the plant. A potato plant, left, is eaten by both adult and larvae of the Colorado beetle.

The beetles come out of the ground in spring and lay their yellow eggs in clusters on the underside of the leaves of the potato plant. The soft-bodied, orange-red larvae feed on the tender leaves, as do the adult beetles. After three weeks of greedy eating, the larvae drop off, burrow into the ground, and emerge as full-grown insects about 10 days later. There may be two or three broods a season.

The Colorado beetle is a difficult pest to control. Insecticides have been used, but the beetles have gradually developed resistance to most of the chemicals.

Scientific classification. The Colorado beetle belongs to the leaf beetle family, Chrysomelidae, order Coleoptera. It is *Leptinotarsa decemlineata*.

See also **Beetle**.

Colosseum, also called the Flavian Amphitheatre, was the largest outdoor theatre of ancient Rome. The Colosseum still ranks among the finest examples of Roman architecture and engineering, even though it survives only as a ruin. It stands near the centre of modern Rome.

Construction of the Colosseum started during the reign of the Emperor Vespasian, who ruled from A.D. 69 to 79. The building was dedicated in A.D. 80. Until 404, the Colosseum was the site of mock naval battles, combat between gladiators, battles between men and wild animals, and other public entertainment. After that date, gladiatorial battles were no longer held, but fights with wild animals continued there until 523. During the Middle Ages, stones from the structure were used to construct new buildings.

The Colosseum has four storeys and is oval in shape. It could seat about 50,000 spectators on marble and wooden benches. The Colosseum is 48 metres high, about 190 metres long, and about 155 metres wide. The arena on the floor of the Colosseum is about 85 metres long and 55 metres wide. A wall about 4.5 metres high separated spectators from the arena.

The Colosseum is made of brick and concrete with stone covering the exterior. The first three storeys consist of arches decorated with half columns. The fourth storey was added later and has plainer decoration. Large brackets in the fourth-storey walls held poles that



The Colosseum, or Flavian Amphitheatre, in the centre of Rome, is one of the most famous ruins in the world.

supported awnings to protect spectators from the sun and rain. The Colosseum had about 80 entrances, 2 reserved for the emperor.

See also **City** (picture: Rome).

Colossians, Epistle to the, is the 12th book of the New Testament. It is a letter from the apostle Paul to the Christians in Colossae (in what is now western Turkey). Some scholars doubt that Paul actually wrote the letter. They believe it was written in his name by one of his followers. If Paul wrote Colossians, he did so while in prison, possibly in Rome, in about A.D. 60.

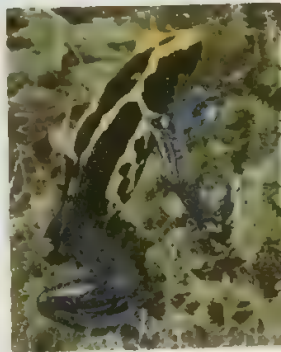
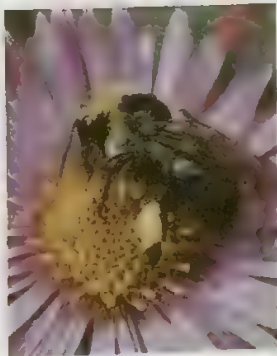
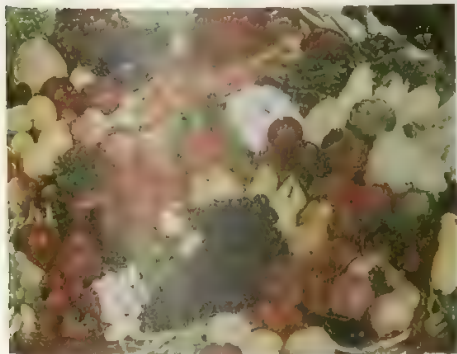
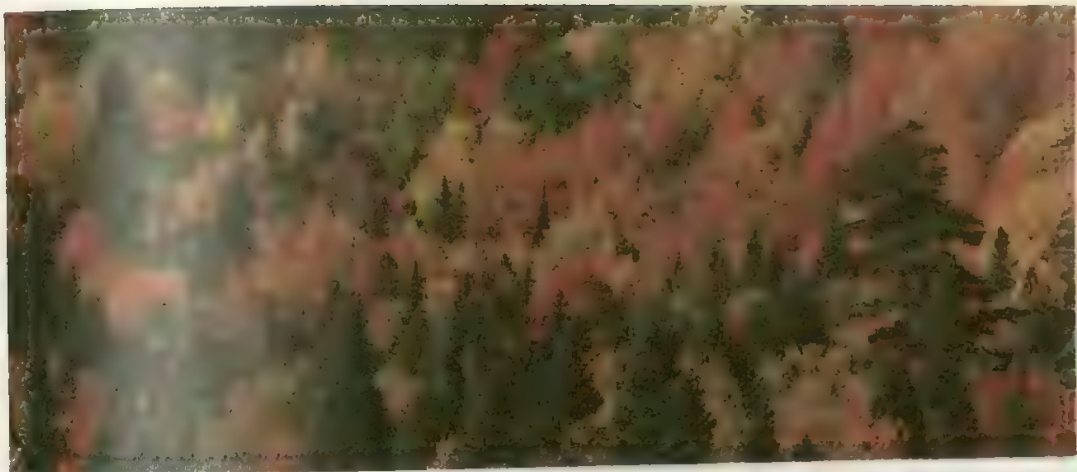
Colossians is mainly a warning against combining Christianity with a "philosophy" (Col. 2:8) that involved Jewish observances among other things. The author argued that faith in Jesus is completely sufficient, and that nothing need be added to it.

See also **Paul, Saint; Bible** (Books of the New Testament).

Colossus of Rhodes. See **Seven Wonders of the Ancient World**.



The Colosseum originally had a wooden floor, below which was a network of passages and chambers. Wild animals were housed in the chambers before they were brought into the arena.



The great variety of colours in nature includes the dazzling colours of autumn leaves, *top*, and the appetizing colours of ripe fruits and vegetables, *above left*. A brightly coloured flower, *above centre*, attracts a honeybee to its pollen. The brilliant blue and yellow of a South American arrow poison frog, *above right*, serve as a vivid warning to the animal's enemies.

Colour

Colour fills our world with beauty. We delight in the colours of a magnificent sunset and in the bright red and golden-yellow leaves of autumn. We are charmed by gorgeous flowering plants and the brilliantly coloured arch of a rainbow. We also use colour in various ways to add pleasure and interest to our lives. For example, many people choose the colours of their clothes carefully and decorate their homes with colours that create beautiful, restful, or exciting effects. By their selection and arrangement of colours, artists try to make their paintings more realistic or expressive.

Colour serves as a means of communication. In sports, different coloured uniforms show which team the players are in. On the roads, a red traffic light tells drivers to stop, and a green light tells them to go. On a map printed in colour, blue may stand for rivers and other bodies of water, green for forests and parks, and red for roads.

We use the names of colours in many common expressions to describe moods and feelings. For example,

we say a sad person *feels blue* and a jealous one is *green with envy*. We say an angry person *sees red*. A coward may be called *yellow*.

Colour plays an important part in nature. The brilliant colours of many kinds of blossoms attract insects. The insects may pollinate the flowers, causing the plants to develop seeds and fruits. Colourful fruits attract many kinds of fruit-eating animals, which pass the seeds of the fruits in their droppings. The seeds may then sprout wherever the droppings fall. In this way, fruit-bearing plants may be spread naturally to new areas.

The colours of some animals help them attract mates. For example, a peacock spreads his brightly coloured feathers when courting a female. The colours of many other animals help them escape from enemies. For example, Arctic hares have brownish fur in summer. In winter, their fur turns white, making it difficult for enemies to see the hares in the snow.

Although we speak of seeing colours or objects, we do not actually see them. Instead, we see the light that



The Old Guitarist (1903), an oil painting on wood panel.
The Art Institute of Chicago



Communicating with colour. Colour is often used to express moods and to communicate information. The use of blues in Pablo Picasso's painting *The Old Guitarist*, above left, creates a sad and lonely feeling. The exciting colours of a neon sign, upper right, capture people's attention. The colours worn by rugby union players, lower right, help spectators tell which team the players are in.

objects reflect or give off. Our eyes absorb this light and change it into electrochemical signals. The signals travel through nerves to the brain, which interprets them as coloured images. However, there is much that scientists still do not know about how our eyes and brain enable us to sense colour.

The relation between colour and light

To understand how we see colour, we must first know something about the nature of light. Light is a form of energy that behaves in some ways like waves. Light waves have a range of *wavelengths*. A wavelength is the distance between any point on one wave and the corresponding point on the next wave. Different wavelengths of light appear to us as different colours. Light that contains all wavelengths in the same proportions as sunlight appears white. Some other mixtures of wavelengths appear white too. See *Light*.

When a beam of sunlight passes through a specially shaped glass block called a *prism*, the rays of different

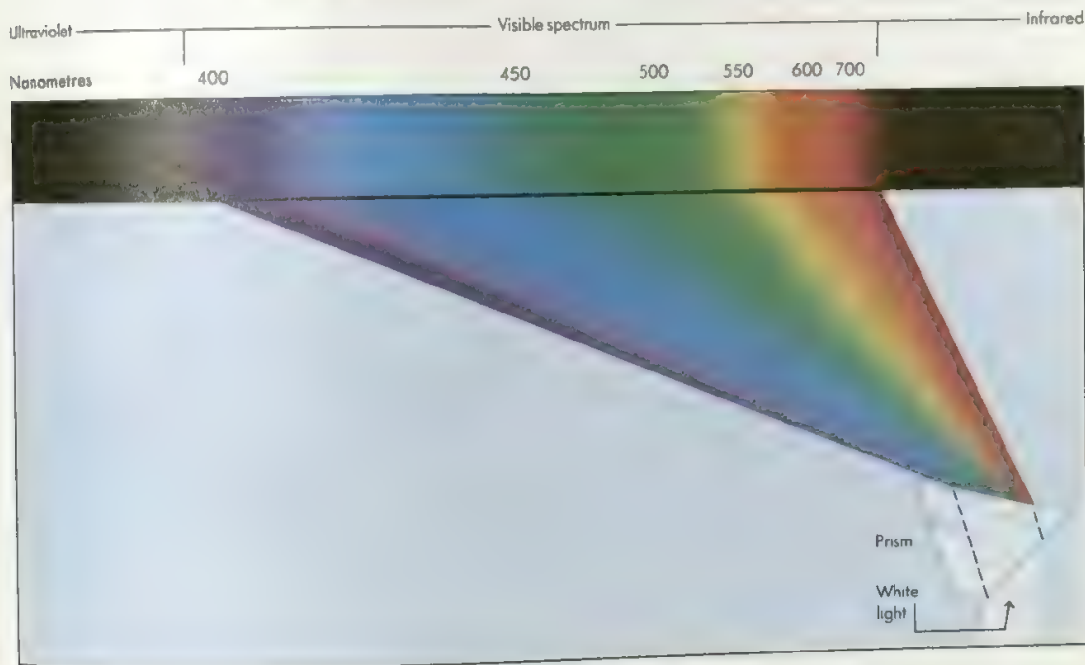
wavelengths are bent at different angles. The bending breaks up the sunlight into a beautiful band of colours. This band contains all the colours of the rainbow and is called the *visible spectrum*. At one end of the spectrum the light appears as violet. It consists of the shortest wavelengths of light that we can see. Farther along the spectrum, the light has increasingly longer wavelengths. It appears as blue, green, yellow, orange, and red, each shading into its neighbouring colours in the spectrum. The longest wavelengths of light that we can see appear deep red in colour.

Light waves are *electromagnetic waves*, which consist of patterns of electric and magnetic energy. The visible spectrum is only a small part of the *electromagnetic spectrum*—the entire range of the wavelengths of electromagnetic waves. Beyond the violet end of the visible spectrum are ultraviolet rays, X-rays, and gamma rays. Beyond the red end of the visible spectrum are infrared rays and radio waves. See *Electromagnetic waves*.

Such objects as traffic lights and neon signs appear

The visible spectrum

A band of colours called the *visible spectrum* forms when white light passes through a *prism* (a specially shaped glass object). The prism bends the shortest light waves most. They appear violet. It bends the longest waves least. They appear red. All other colours lie in between. Ultraviolet and infrared fall outside the spectrum and are invisible to people. The length of light waves is measured in *nanometres*. One nanometre is a billionth of a metre.



coloured because the light that they give off contains a limited range of wavelengths. However, most objects appear coloured because of their chemical structure. They absorb certain wavelengths of light and reflect others. When sunlight strikes an object such as a carrot, for example, molecules in the carrot absorb most of the light of short wavelengths. Most of the light of longer wavelengths is reflected. When these longer wavelengths of light reach our eyes, the carrot appears orange.

An object that reflects most of the light of all wavelengths in nearly equal amounts appears white. An object that absorbs most of the light of all wavelengths in nearly equal amounts appears black.

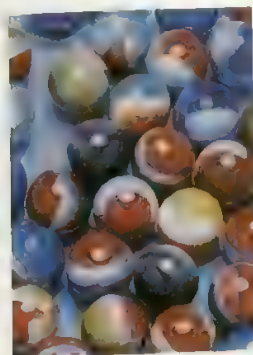
How we see colour

The roles of the eyes and brain. Our ability to see colour depends on many highly complicated workings of the eyes and brain. When we look at an object, light coming from the object enters our eyes. Each eye focuses the light, forming an image of the object on the *retina*. The retina is a thin layer of tissue covering the back and sides of the inside of the eyeball. It contains millions of light-sensitive cells. These cells absorb most of the light that falls on the retina and convert the light into electrical signals. These electrical signals then travel through nerves to the brain.

The retina has two main types of light-sensitive cells—*rods* and *cones*. The cells are named after their shapes. Rods are extremely sensitive to dim light but cannot distinguish wavelengths. For this reason, we see only tones

of grey in a dimly lit room. As the light becomes brighter, the cones begin to respond and the rods cease functioning. The retina of a person with normal colour vision has three types of cones. One type responds most strongly to light of short wavelengths, which corresponds to the colour blue. Another type reacts chiefly to light of middle wavelengths, or green. The third type is most sensitive to light of long wavelengths, or red.

The brain organizes nerve signals from the eye and interprets them as coloured visual images. Exactly how the brain makes us aware of colours is still much of a mystery. Scientists have developed several theories to



Colour vision requires a certain level of lighting. In dim light, coloured objects, such as marbles, *above left*, appear grey. In bright light, the same objects, *above right*, appear in colour.

explain colour vision. Some of these theories are discussed in the section *History of colour studies*.

Some people do not have full colour vision. Such people are said to be colour blind. There are different types and degrees of colour blindness, depending on different abnormalities in the retina's cones. In severe cases, one type of cone may be absent or not functioning. People who have such an abnormality confuse certain colours with others. Very few people cannot see colours at all. Most colour-vision problems are inherited and cannot be cured. See **Colour blindness**.

Surprising colour-vision effects. Many operations of the eyes and brain work automatically and almost instantly in providing us with colour vision. We have learned unconsciously not to "see" certain visual effects of these operations, especially as our eyes adjust to changes of colour. When we do become aware of such effects, they may seem dramatic or startling. Some of the colour-vision effects that we normally do not notice can be easily demonstrated.

We can demonstrate one colour-vision effect by covering half a sheet of brightly coloured paper with plain white paper. If we stare at the coloured area for about 30 seconds and then remove the white paper, the area that had not been covered will seem much lighter than the half that had been covered. It seems lighter because our eyes *adapt* to (become accustomed to) colours. Such a visual effect is called *chromatic adaptation*.

If we stare at a coloured image for about 30 seconds and then look at a white surface, we see an *afterimage*. The afterimage has the same shape as the original image but different colours. Where the original image was red, the afterimage will be green. Where the image was green, the afterimage will be red. Blue areas become yellow, and yellow areas become blue. Black and white also reverse. The technical name for this amazing colour-vision effect is *successive contrast*.

We can also demonstrate that the appearance of a colour is influenced by surrounding colours. If we place



Phantom colours are colours that appear in areas that are only black and white. A faint area of phantom pink can be seen in the centre of the triangle formed by the three circles above.

the same colour against different background colours, the colour will look different in each case. In addition, a colour appears lighter when surrounded by a dark background than when surrounded by a light background. This colour-vision effect is called *chromatic induction* or *simultaneous contrast*.

Sometimes, we may see colours in areas that are only black and white. Such colours are called *phantom colours*. Phantom colours may be seen by staring at flashing black-and-white patterns, such as those produced by a rapidly rolling black-and-white television picture.

Colour vision in animals

Apes, monkeys, many kinds of birds, and some species of fishes have colour vision much like ours. However, numerous other animals see colours differently from the way we do. For example, research shows that crocodiles see colours as various shades of grey. The eyes of certain other animals are sensitive to light that we cannot see. For example, bees can see ultraviolet light, which is invisible to people. On the other hand, bees cannot see the colour red.

Methods of colour production

Manufacturers, artists, and craftworkers produce objects in a tremendous variety of colours. To create so many different colours, they use one of two basic methods. These methods are (1) mixing colorants and (2) mixing coloured lights.

Mixing colorants. A great variety of colours can be created by mixing *colorants*. Colorants are chemical substances that give colour to such materials as ink, paint, crayons, and chalk. Most colorants consist of fine powders that are mixed with liquids, wax, or other substances to make them easier to apply to objects. Colorants that dissolve in liquids are called *dyes*. Colorants that do not dissolve but spread through liquids or other



To see an afterimage, stare at the centre of the flag for about 30 seconds. Then look at a sheet of white paper. You will see an image of the flag with its proper colours.

substances as tiny solid particles are called *pigments*.

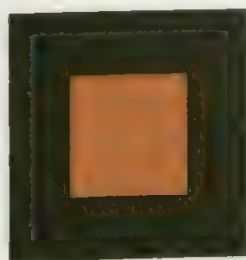
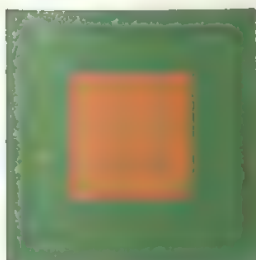
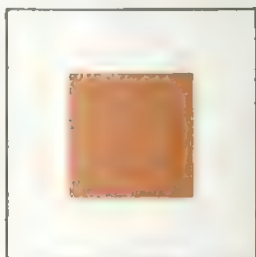
When two different colorants are mixed, a third colour is produced. For example, when paint with blue pigment is mixed with paint that has yellow pigment, the resulting paint appears green. When light strikes the surface of this paint, much of it penetrates the paint layer and hits pigment particles. The blue pigment absorbs most of the light of long wavelengths—light that appears red, orange, and yellow. The yellow pigment absorbs most of the light of short wavelengths—light that appears blue and violet. Most of the light of me-

dium wavelengths is not absorbed but reflected through the surface of the paint. When this light reaches our eyes, we see the paint as green. In a colorant mixture, each colorant absorbs, or subtracts, some of the wavelengths of light that strike it. For this reason, colorant mixtures are sometimes referred to as *subtractive colour mixtures* or *colour by subtraction*.

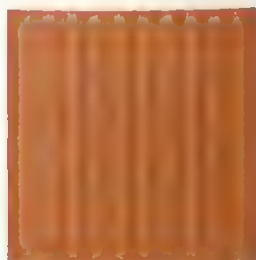
Any three colorants that can be mixed in different combinations to produce nearly any other colour are known as *primary colorants* or *primary colours in paint*. A common group of primary colorants consists of red,

The effects of neighbouring colours

The appearance of a colour is influenced by the other colours around it. The same colour looks different when it is placed against different background colours. In addition, in certain two-colour combinations, the colours seem to mix, forming a third colour. In some other combinations, however, the colours seem to clash, creating a sense of visual vibration.



A colour looks different against different background colours. The orange squares in the above illustrations are all the same colour. But the orange seems lighter against the black background than against white or grey. It appears more yellow against green than against grey or white.



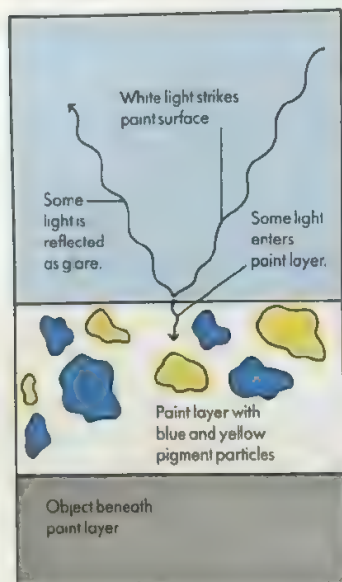
Visual mixing occurs when two colours seem to blend, forming a third colour. Seen from a distance, the red and orange above seem to form a red-orange square.



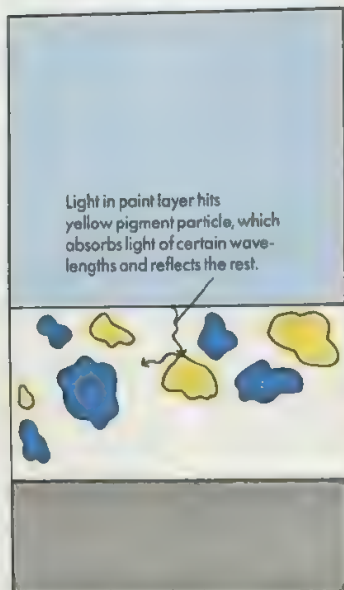
Visual vibration occurs when two colours seem to clash and vibrate in our vision. The purple and yellow stripes appear to flash, dazzling our eyes.

How a mixture of two pigments produces a third colour

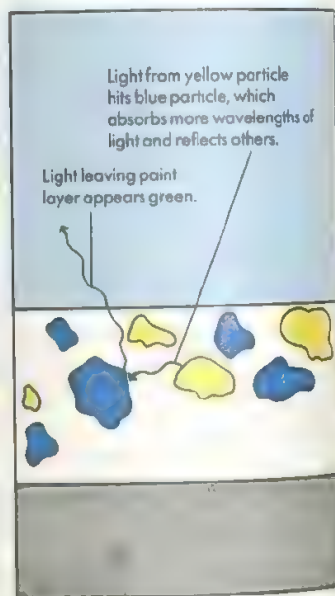
When light strikes *pigments* (colouring particles) in paint, the pigments absorb, or subtract, certain wavelengths of light and reflect others. In paint containing a mixture of different pigments, each pigment subtracts different wavelengths. The colour we see depends on what wavelengths have been subtracted, so producing colours in this way is called *colouring by subtraction*.



Light strikes the surface of a paint layer containing blue and yellow pigment particles. Some light is reflected as glare, and the rest penetrates the paint.



Light strikes a yellow particle, which absorbs, or subtracts, the light of short wavelengths and reflects the light of longer wavelengths.

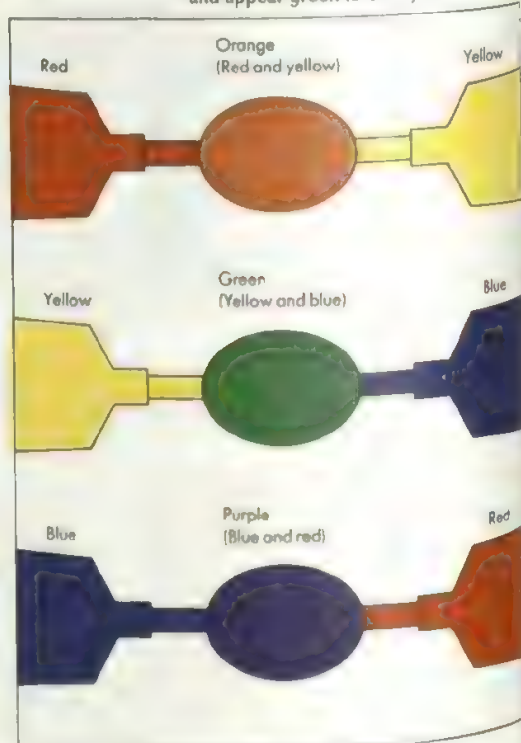


Light strikes a blue particle, which absorbs light of long wavelengths. Medium wavelengths are reflected from the paint and appear green to our eyes.

yellow, and blue. When primary colorants are mixed in pairs, the resulting colours are called *secondary colorants* or *secondary colours in paint*. Orange is formed by mixing red and yellow, green by mixing yellow and blue, and purple by mixing blue and red. Colour experts have found that *magenta* (purplish-red), yellow, and *cyan* (blue-green) also make a good set of primary colorants. These three colorants can be mixed to produce an extremely wide range of colours.

Mixing equal amounts of three primary colorants results in a colour that is almost black. However, special black colorants, such as a fine black powder called *carbon black*, provide better blacks. Mixing black with a colour produces a *shade*. Primary colorants absorb much light, and so they cannot be mixed to produce very light colours. For such purposes, either a chemical compound called *titanium dioxide* or some other special white colorant must be added. Mixing white with a colour produces a *tint*. The combination of black and white forms grey. Mixing grey with a colour creates a *tone*.

Mixing coloured lights. When lights of different colours are projected together onto a screen, they blend and form new colours. Mixing coloured lights produces new colours differently from the way mixing colorants does. Mixing colorants results in new colours because each colorant subtracts some wavelengths of light. But mixing coloured lights produces new colours by adding light of different wavelengths. For this reason, coloured light mixtures are sometimes called *additive colour mixtures* or *colour by addition*.



Primary and secondary colours in paint. Red, yellow, and blue are common primary colours. They can be mixed to form the secondary colours orange, green, and purple.

The colour triangle

A colour triangle has a colour or white or black at each point. Adding white to a colour produces a *tint*. Adding black forms a *shade*. Adding grey (a mixture of black and white) creates a *tone*.



In an additive colour mixture, the primary colours differ from those in paint. The *primary colours in light* are red, green, and blue. When red and green lights are mixed, the result is yellow light. A mixture of blue and green lights forms blue-green light, and blue and red lights form purple light. Combining all three primary colours in light in the proper proportions results in white light.

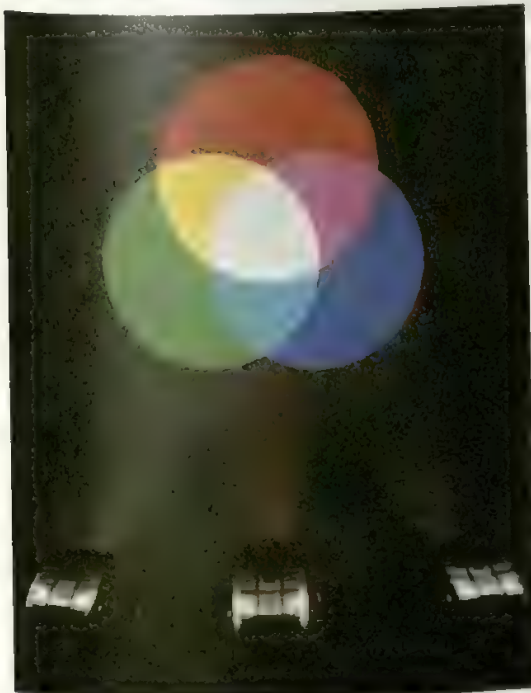
The colours of any two lights are *complementary* if they form white light when mixed. Therefore, the complementary colour of any primary colour in light is the colour formed by combining the two other primary colours. The complement of blue is yellow (red light plus green light). The complement of red is blue-green (blue light plus green light). The complement of green is purple (red light plus blue light).

Colour television pictures are created by additive mixtures of the three primary colours in light. A colour TV screen has thousands of tiny areas that glow when struck by a beam of electrons. Some areas produce red light, others produce green light, and still others produce blue light. When we watch a colour programme, we do not see each red, green, or blue area. Instead, we see a range of many colours produced when the red, green, and blue lights blend in our vision. We see white light when certain amounts of red, green, and blue light

Mixing coloured lights

Lights of different colours are made up of different wavelengths. Projecting two different coloured lights together onto a screen results in a new colour because the wavelengths of one light are added to those of the other. So mixing coloured lights is also called *colouring by addition*.

Primary colours in light



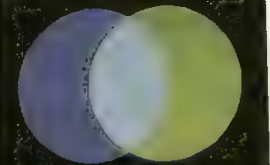
Red, green, and blue are the primary colours in light. They can be combined in various ways to form different colours. Combining all three primary colours results in white light.

Complementary colours in light

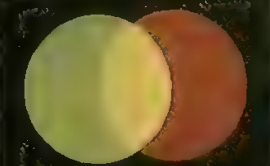
A blend of red and blue lights creates purple, the complement of green.



A blend of blue and green lights creates blue-green, the complement of red.



A blend of green and red lights creates yellow, the complement of blue.



The complement of a primary colour in light is produced by combining the two other primary colours. The colours that result are shown above.

are combined. The combining of the primary colours to produce white light makes it possible for a colour TV to show black-and-white pictures. See **Television** (How television works).

Producing colour harmony

When neighbouring colours have a pleasing effect, we say that they produce colour harmony. In selecting clothes or decorating homes, many people consider which colours look good together. Artists and scientists

have developed guidelines for combining colours. But there are no fixed rules of colour harmony because too many factors affect whether colours go well together.

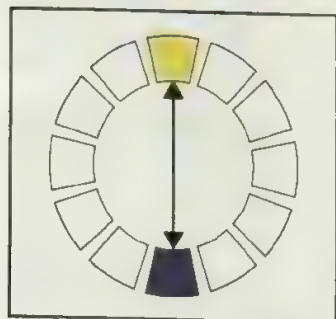
A *colour circle*, or *colour wheel*, shows the relations among colours. It is a helpful tool for choosing harmonious colour combinations. A colour circle consists of a range of colours in the form of a circle. The colours run from red, through the other colours of the spectrum, and back to red again. Three colours an equal distance apart on the colour circle are called a *colour triad*. The

The **colour circle**, also called the *colour wheel*, indicates the relations among colours. The outer circle shows three primary colours (yellow, red, and blue) and three secondary colours (orange, purple, and green) labelled in boldface capital letters. They are separated by six intermediate colours labelled in lightface capitals. The inner circle shows darker colours obtained by mixing two colours that lie opposite each other in the outer circle.

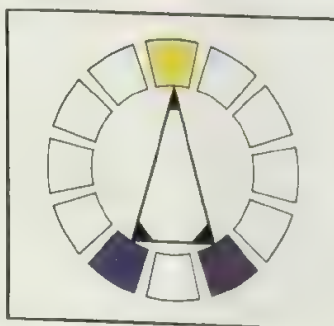


Harmonious colour combinations

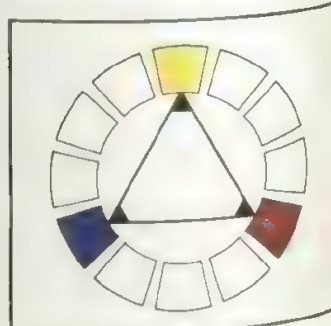
Certain colours have a pleasing effect when used together. The diagrams below show how harmonious colour combinations can be found by connecting various positions on the colour circle.



Complementary colours in paint, such as yellow and purple, lie directly opposite each other on the colour circle.



Near-complementary colours, such as yellow and red-purple or yellow and blue-purple, lie nearly opposite.



A triad consists of three colours spaced an equal distance apart, such as the primary colours yellow, red, and blue.

colours in a triad often go well together. The primary colours on the colour circle—red, yellow, and blue—form a triad. The *secondary colours*—green, orange, and purple—are mixtures of two primary colours. They lie at equal distances from the primary colours and also form a triad. *Intermediate colours* are mixtures of a primary and a secondary colour. They lie between primary and secondary colours. A mixture of two secondary colours forms a *tertiary colour*.

Any two colours that lie directly opposite each other on the colour circle are called *complementary colours* in paint. Such pairs of complementary colours include red and green, orange and blue, and yellow and violet. Complementary colours often go well together. A colour also may harmonize with colours that lie next to its complement, such as red with blue-green or yellow-green. Such colours are called *near-complementary colours* or *split complementary colours*. Colours that lie next to each other on the colour circle, such as blue-green, blue, and blue-violet, also may form pleasing combinations. *Monochromatic* colour schemes are made up of shades, tones, and tints of a single colour. Such colour combinations can create pleasant effects. For more information on producing colour harmony, see *Interior decoration* (Using colour; Colour and light; pictures).

Characteristics of colour

Every colour has three basic characteristics. They are (1) hue, (2) lightness, and (3) chroma. Colour experts describe an object's colour in terms of these characteristics.

Hue is the property that gives a colour its name—for example, red, orange, yellow, green, blue, or violet or a combination of such names. The dramatic differences that we see among the colours in the spectrum are produced by very slight differences in the wavelengths of light. For example, the wavelengths that appear as yellow are only slightly shorter than those that appear as orange. But there is a great visual difference between orange and yellow. This difference is a difference in hue.

Lightness is a measurement of the amount of light reflected from a coloured object. The lightness of a colour may be expressed by comparing the colour's level of reflected light with that of samples on a lightness scale. A lightness scale runs from black, through shades of grey, to white. Black reflects very little light. A colour that reflects about the same amount of light as black has a very low lightness level. Grey reflects more light than black. Thus, a colour that reflects about the same amount of light as a shade of grey may have an intermediate level of lightness. White reflects nearly all the light that strikes it. Therefore, a colour that reflects about the same amount of light as white has a very high lightness level. Colour experts use the term *brightness* to describe the lightness level of a coloured light source.

Chroma is a measurement of the *saturation* (concentration) of a colour. For example, a teaspoon of red poster paint powder mixed with a teaspoon of water produces paint of a deep red colour. The paint has a high concentration of red colorant, and so it has a high chroma. If we dilute the paint with a cup of water, the resulting mixture will have a low concentration of red colorant and, therefore, a low chroma.

How colours are classified

Experts estimate that we can distinguish perhaps as many as 10 million colours. Each colour differs from all others in some degree of hue, lightness, or chroma. Our names for colours are far too inexact to describe accurately all the colours we see. As a result, people often have difficulty trying to describe or match a certain colour. Matching colours is especially important in such industries as paint and textile manufacturing. Manufacturers of paints and textiles must minimize differences in the colour of a particular paint or fabric from one batch of paint or bolt of fabric to another.

To overcome problems in describing and matching colours, colour experts have developed various systems of classifying colours. Two widely used classification systems are (1) the Munsell Colour System and (2) the CIE System of Colour Specification.

The Munsell Colour System is one of the most popular and useful means of classifying colours. It was developed in the early 1900's by Albert H. Munsell, an American portrait painter. The system classifies colours according to the three basic characteristics of hue, lightness, and chroma. However, Munsell used the term *value* for lightness.

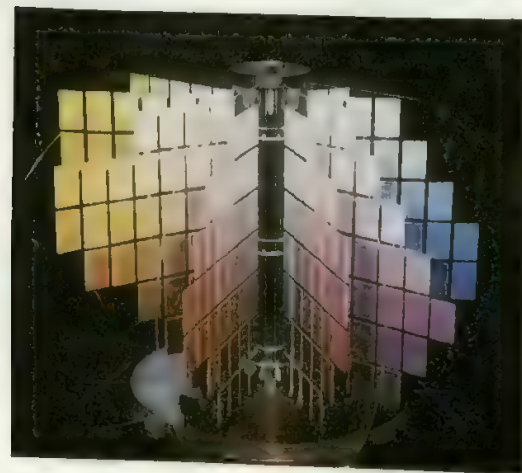
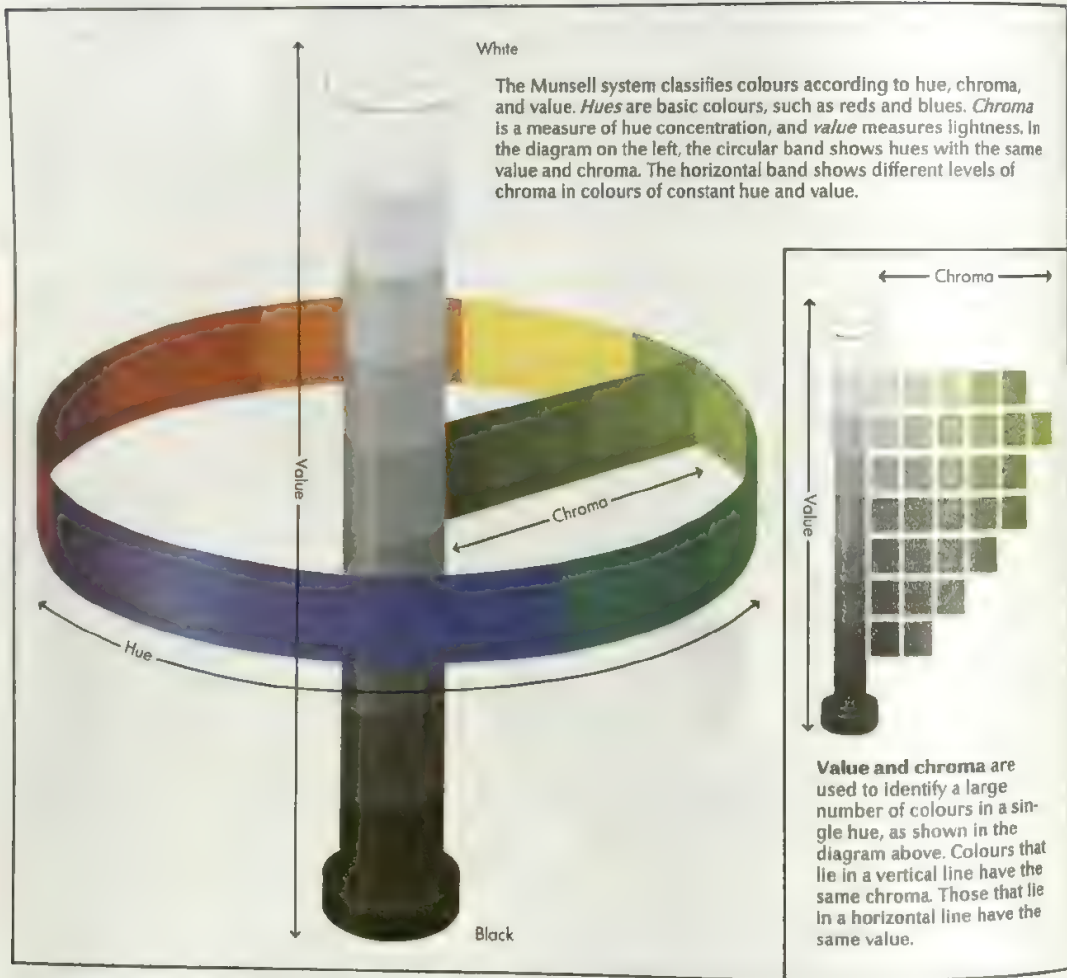
The Munsell system may be displayed in many ways. A common display shows samples of different colours arranged around a vertical axis. Different hues are arranged around the axis like the spokes of a wheel, with each spoke consisting of a different hue. The axis serves as the value, or lightness, scale. It is divided into 10 sections. These sections correspond to 10 levels of value from black at the bottom, through shades of grey, to white at the top. All colour samples at the same level have the same value. Colours close to the axis have low chroma. The farther from the axis a colour is located, the higher is its chroma.

To match a particular colour using the Munsell system or a similar system, one must find that colour among the colour samples provided. However, the number of samples in such systems cannot approach the number of colours we are able to distinguish. For this reason, it is sometimes impossible to find an exact colour match.

The CIE System of Colour Specification. Manufacturers of such products as foods, paints, paper, plastics, and textiles must often match colours precisely. Because colour vision varies among people, two colours that match for one person may not match for another. For this reason, manufacturers do not rely on the human eye to match colours precisely. Instead, they use the CIE System of Colour Specification. CIE stands for Commission Internationale de l'Éclairage (International Commission on Illumination), an international organization that establishes standards for measuring colour.

A paint manufacturer who wants to produce the same colour of green paint at two factories may use the CIE system to make sure that the two greens match. First, colour experts analyse the colour of the green paint made at one factory to determine the wavelengths of light that compose it. They make the analysis with a *spectrophotometer*. This instrument separates the light reflected from the paint into its various wavelengths and measures their *intensity* (strength). Then, tables of num-

The Munsell Colour System



A Munsell colour tree displays many colour samples arranged around a central axis. Such a colour tree can be helpful when a person is trying to match a particular colour.

bers are used to convert this information into three numerical values—one for each of the primary colours in light, which will match the original green when mixed. These tables of numbers, called *standard observers*, define the colour-matching properties of a human eye having normal colour vision.

The paint made at the second factory is also analysed using a spectrophotometer. Small amounts of pigment are then added to adjust the colour of the paint. Pigment is added until the analysis results in the same three primary colour values that were produced by the paint made at the first factory. When these three primary colour values are reached, the two green paints will match, even though they may contain different mixtures of pigments.

History of colour studies

Early theories of colour vision. Many thinkers in ancient times developed theories about the nature of colour. Since then, scientific experiments have confirmed some of their ideas and disproved others.

Empedocles, a Greek philosopher of the 400's B.C.,

believed that colour vision was caused by tiny particles that were given off by objects and passed through the eyes. He thought that the eyes either produced a colour reaction to the particles or recognized them as coloured. In the early 300's B.C., the Greek philosopher Plato proposed that colour vision was caused by rays that shot out from the eyes toward objects. Aristotle, a Greek philosopher of the later 300's B.C., may have been the first person to realize that there is a relation between colour and light. However, he also thought that colour was caused by something transparent between objects and the eyes. Galen, a Greek doctor of the A.D. 100's, believed that colour vision arose because rays from the eyes empowered the surrounding air to carry tiny images of objects to the eyes. He thought that these images then were analysed by a visual spirit which moved between the eyes and the brain.

During the early 1000's, an Arab physicist known as Alhazen recognized that vision is caused by the reflection of light from objects into our eyes. He stated that this reflected light forms optical images in the eyes. Alhazen believed that the colours we see in objects depend on the light striking the objects and on some property of the objects themselves.

Newton and Goethe. During the late 1600's and early 1700's, Sir Isaac Newton, an English scientist, performed many experiments to investigate the nature of colour. Using a prism, Newton demonstrated that white light contains all the colours of the rainbow. He also was the first person to show that coloured lights can be combined to form white light. Newton realized that light rays themselves are not coloured but that the sensation of colour is produced in the brain.

During the late 1700's and early 1800's, Johann Wolfgang von Goethe, a German poet, experimented with coloured lights and shadows. He wrote a book on optics that seemed to contradict many of Newton's findings. Goethe did not believe that coloured lights could be combined to form white light. He thought that all coloured lights were actually mixtures of light and darkness. Goethe's experiments were useful in demonstrating many aspects of colour vision. However, Goethe's theories of colour vision based on these experiments are no longer accepted by scientists.

The three-component theory of colour vision was proposed in 1801 by Thomas Young, an English physicist. It was further developed during the 1850's by a German physicist, Hermann von Helmholtz. The three-component theory is also known as the *Young-Helmholtz theory* or the *trichromatic theory*. The theory proposes that the eye has three types of fibres that are sensitive to different wavelengths of light. When light strikes the fibres, they generate electrical signals that travel directly to the brain. According to the three-component theory, the colour sensations that arise in the brain correspond to the electrical signals in a simple and direct way. Scientific experiments have confirmed the existence of the three types of fibres, which are now called *cones*. Each type of cone is particularly sensitive to one of three general ranges of wavelengths of light—those corresponding to red, green, and blue.

The opponent colour theory was proposed in 1874 by Ewald Hering, a German physiologist. Hering suggested that, somewhere in the nerves of the eyes and

brain, there are two response mechanisms, each of which involves a pair of opposing colours. This means that the response mechanisms can signal only one of the two colours at a time. One response mechanism signals either red or green, and the other signals either yellow or blue. A third mechanism signals the level of lightness. The brain interprets these signals, producing our sense of colour. The opponent colour theory explains many aspects of colour vision better than the three-component theory does. For example, the opponent colour theory provides an explanation for the fact that we see no such colours as reddish-green or yellowish-blue.

Recent theories combine ideas from the three-component and opponent colour theories to describe the various stages of colour vision. In the first stage of colour vision, three types of cones in the retina absorb light and generate electrical signals, as proposed by the three-component theory. During the second stage of colour vision, nerves in the eyes and brain create three new signals, which correspond to those described by the opponent colour theory. The nerve signals may pass through further stages before the brain finally interprets them as the sensation of colour.

Study aids

Related articles in *World Book* include:

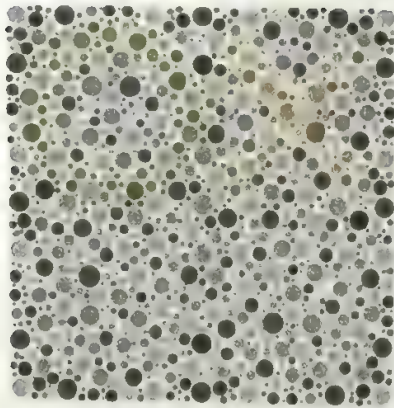
Animal (Animal defences; picture: Animal camouflage)	Pigment
Colour blindness	Printing: picture: Printing with process colours
Dye	Prism
Electromagnetic waves	Protective coloration
Eye	Rainbow
Interior decoration	Spectrometer
Light	Technicolor
Newton, Sir Isaac	Television (How television works; illustration)
Paint	

Outline

- I. The relation between colour and light
- II. How we see colour
 - A. The roles of the eyes and brain
 - B. Surprising colour-vision effects
- III. Colour vision in animals
- IV. Methods of colour production
 - A. Mixing colorants
 - B. Mixing coloured lights
- V. Producing colour harmony
- VI. Characteristics of colour
 - A. Hue
 - B. Lightness
 - C. Chroma
- VII. How colours are classified
 - A. The Munsell Colour System
 - B. The CIE System of Colour Specification
- VIII. History of colour studies

Questions

- What are the three basic characteristics of every colour?
- Why does a carrot appear orange?
- Who was the first person to show that coloured lights can be combined to form white light?
- What is the *visible spectrum*?
- How is a *tint* produced? A *shade*? A *tone*?
- What are the three *primary colours* in light?
- Why do we see only tones of grey in a dimly lit room?
- What is a colour *triad*?
- Why are colorant mixtures sometimes called *subtractive colour mixtures*?
- What are *phantom colours*?



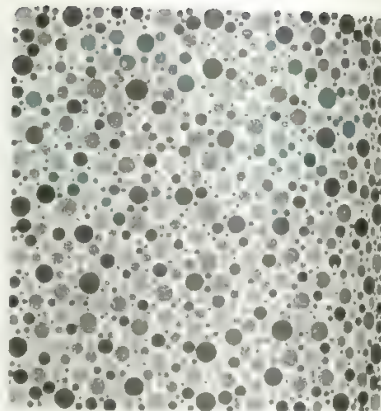
Testing colour vision.

These colour patterns are examples of the figures used to find out whether people confuse certain colours with others.

On the left, people who confuse both blue and yellow may not see the ○ and ×.

On the right, people who confuse both red and green may not see the ○ and ▷.

These plates are the copyright of the American Optical Company and are reproduced here with permission. However, these reproductions do not present true testing conditions and cannot be used as a colour vision deficiency test.



Colour blindness, sometimes called daltonism, is the inability to tell all colours apart. The ability to see colour originates in specific visual cells, called *cones*, in the retina of the eye. A person with normal colour vision has three types of cones, and each type is sensitive to a different colour. Colour-blind people lack one, two, or all of these types of cones.

Most colour-blind people have *dichromatic vision*. People with this kind of colour blindness can see only yellows and blues. They confuse reds with greens, and some reds or greens with some yellows. Only a very few people are truly blind to all colours. They have *achromatic vision*. They see in shades of white, grey, and black—somewhat like a black-and-white photograph.

More men than women are colour blind. About 8 out of every 100 men are colour blind, compared with about 1 out of every 200 women. There is no cure for colour blindness.

Many animals, including cats and horses, probably do not see colours as we do. But the condition is normal in their eyes, not defective.

Many colour-blind people do not realize that their eyesight is defective. They have learned to use the colour names that everyone else uses. These people may be hampered in their everyday activities, and their condition may place them in danger. If they confuse red and

green, for example, they may only be able to tell traffic lights apart by their brightness or sequence. Many armed forces refuse to accept colour-blind people for military service. In addition, colour blindness can be a hindrance for airline pilots, fashion designers, and members of certain other professions.

Most people can be easily tested for colour blindness. Some tests indicate both the type and the degree of colour blindness. In these tests, coloured triangles, squares, and other shapes lie in a jumble of dots. These dots vary in both colour and intensity. From the coloured shapes that the person is able to identify, an examiner can determine the person's ability to see different colours. Other tests measure a person's ability to match colours.

Colour blindness is inherited. If a colour-blind man marries a woman who has no family history of colour blindness, their children will have normal vision. Their daughters, however, will carry the gene for colour blindness, and may pass it on to their children. If a woman whose father is colour blind marries a man with normal vision, each of their sons has a 50-50 chance of inheriting the disorder. Injury to the retina or optic nerve and various diseases of the eye can also cause colour blindness.

See also Eye (Colour blindness).



To a colour-blind person, some colours look the same. A person who confuses red and green with other colours may say these pictures look the same or are equally colourful. Most people with normal colour vision would say the photograph on the right is the more colourful of the two shown here.



Colster, Willem Joosten Van, a Dutch explorer, charted the west coast of the Gulf of Carpentaria, in Northern Australia. In 1623, he sailed in the *Arnhem* from Batavia (now Jakarta, Indonesia) to *Nova Hollandia* (New Holland), now Australia. Together with Jan Carstensen in the *Pera*, he charted the west coast of Cape York Peninsula. The ships separated, and Colster continued southward. He sailed across the Gulf of Carpentaria to what is now Arnhem Land. He anchored at the Wesel Islands, and then returned to the Dutch East Indies. Historians know little more about Colster.

Colt. See Horse (table: Horse terms).

Colt, Samuel (1814-1862), an American gunsmith, developed the first successful repeating pistol. The pistol, patented in England in 1835, had a cylinder of several chambers that could be discharged in succession by the same locking and firing mechanism (see Handgun).

Colt established a factory at Hartford, Connecticut, U.S.A., where he produced arms that were used during the Mexican War (1846-1848) and during the American Civil War (1861-1865). After Colt's death, his company made the six-shooters that were used throughout the American West. Colt was born in Hartford, Connecticut.



Wood engraving (1856) by H. Wright Smith. The New York Public Library, New York City

Samuel Colt

Colter, John (1770?-1813), an American trapper, discovered and explored the Yellowstone region, in the United States. He was born near Staunton, Virginia, U.S.A. In October 1803, he enlisted in the Lewis and Clark expedition near Maysville, Kentucky. The expedition was recruited by the United States government to explore the country's northwestern wilderness.

Colter left the expedition in 1806. He planned to join two companions and remain in the upper Missouri River area for at least two years in pursuit of his fortune. For a considerable period, Colter was lost to civilization. He probably spent his time in the West, wandering along the Missouri River and through the Rocky Mountains. The scene of his greatest activity was along the Yellowstone River. He associated closely with many Indian tribes.

In 1807, Colter was in the Yellowstone Basin on a fur-hunting expedition. During this period, he explored the wild countryside and discovered the great thermal springs area that is now Yellowstone National Park. He also discovered several passes through the Rocky Mountains. Colter's exploits in the mountains have been a basic source of information about frontier expansion in that region. He returned to St. Louis, Missouri, in 1810.

Coltrane, John William (1926-1967), was a famous jazz saxophonist and composer. His sometimes violent style made him one of the most controversial and widely imitated jazz musicians of the 1960's. Coltrane was also one of the first jazz performers to reflect the influence of the music of India.

Coltrane was born in Hamlet, North Carolina, U.S.A. He played in the bands of Dizzy Gillespie and Johnny Hodges during the early 1950's. He achieved greater recognition as a frequent soloist with the Miles Davis quintet between 1955 and 1960. Coltrane formed his own quartet in 1960 with pianist McCoy Tyner, bass player Jimmy Garrison, and Elvin Jones on drums. The quartet scored a popular success with a recording of the song "My Favourite Things." Previously a tenor saxophonist, Coltrane played the soprano saxophone on this record. Coltrane did much to popularize the soprano saxophone among jazz musicians. His use of this instrument in improvisations based on Indian music was particularly influential.

Coltsfoot is a wild plant of Europe and Asia. It also now grows in northeastern United States and in Canada. It is a common plant of bare or sparsely vegetated ground, and grows especially well on clay soil. The coltsfoot has light-yellow flowers that look like dandelion blossoms. The flowers bloom in March or April, and are borne on stems that have no leaves. The heads droop after flowering, but straighten up again when the white seed head is formed. The leaves appear after the flowers have died. They are large and broad, and downy on the underside. The leaves are round at first, but later become shaped like a heart or a colt's foot. The purple coltsfoot is not a true coltsfoot plant.



Coltsfoot

Scientific classification. The coltsfoot is in the composite family, Compositae (Asteraceae). It forms the genus *Tussilago*.

Colugo. See Flying lemur.

Colum, Padraic (1881-1972), was an original member of the group of Irish writers that made Dublin's Abbey Theatre famous. He wrote three important plays for the Abbey—*Broken Soil* (1903, revised as *The Fiddler's House*), *The Land* (1905), and *Thomas Muskerry* (1910). Each is a realistic study of peasant or provincial life intended as part of a connected "comedy of Irish life through all the social stages."

Colum was born in County Longford, in Ireland, and moved to the United States in 1914. He then began writing young people's books based on myth and folklore. These books include *The Adventures of Odysseus* (1918) and *The Children of Odin* (1920).

Colum's verse—from *Wild Earth* (1907) to *Collected Poems* (1953)—is a subtle rendering of simple speech and song patterns. Colum's verse is clear in style and nostalgic in feeling.

Columba, Saint (521-597), founded several monasteries in Ireland and made the island of Iona, off western Scotland, a centre for missionary work. Columba settled on Iona in 563 with 12 companions. He founded a monastery on Iona and spent 34 years in missionary work on the neighbouring islands and on the Scottish mainland. In 574, the Scottish king Aidan visited him for his blessing.

Columba was born at Donegal, in northwestern Ire-



Illustration by J. R. Skelton from *Scotland's Story*, 1906

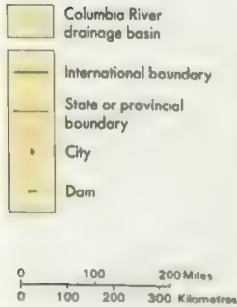
St. Columba, an Irish missionary who lived in the 500's, is shown entering a fortress in Inverness, Scotland.

land. He was also known as Colmcille. St. Columba's feast day is June 9.

Columbanus, Saint (? -615), was an Irish missionary whose work greatly influenced the spread of Christian teaching in Europe. He founded three monasteries in France, the best known of them at Luxeuil. Many of his pupils later set up religious establishments throughout Europe and others became bishops. Columbanus criticized the pagan ways of the French nobility and was eventually exiled. He died in Italy.

Columbia River

The **Columbia River** rises in the Canadian Rockies and drains southeastern British Columbia and much of the Pacific Northwest. More than 50 dams make the river's drainage basin the greatest centre of water power in the world.



In his early life, Columbanus studied in monasteries in Ireland. He left Ireland in about 580. His feast day is November 21. In Ireland, it falls on November 23.

Columbia River is one of the chief rivers of the Western United States and Canada. It is the second longest river in the Western Hemisphere that flows into the Pacific Ocean. Only the Yukon River is longer. The Columbia is 1,954 kilometres long. It drains an area of about 670,800 square kilometres, mostly in the United States.

Dams on the river generate about a third of the hydroelectric power produced in the United States. The Columbia is also a major source of water for irrigation.

The Columbia was named by Captain Robert Gray of Boston, Massachusetts, who sailed into the mouth of the river in 1792. Gray named the river after his ship. In 1805, the American explorers Meriwether Lewis and William Clark travelled down the Columbia. In 1811, the Canadian explorer David Thompson became the first white person to navigate the entire length of the river.

The course of the Columbia. The Columbia River begins in Columbia Lake, which lies in the southeastern part of the Canadian province of British Columbia. From there, it flows northwest for about 320 kilometres, bounded by the Canadian Rockies on the east and the Selkirk Mountains to the west. The river then begins to flow south to the Canadian-United States border.

About 160 kilometres after entering the state of Washington, the Columbia begins a large curve westward. As the river continues to flow west to the Pacific Ocean, it forms the boundary between Washington and Oregon. The Columbia passes through the Cascade Range by way of the Columbia River Gorge. The mouth of the Columbia forms a deep harbour on the Pacific Coast.

Hydroelectric power and irrigation. Thirteen large dams on the Columbia—11 in the United States and 2 in Canada—provide water for hydroelectric power and irrigation. Grand Coulee Dam, about 140 kilometres north-

west of Spokane, Washington, is the greatest single source of water power in the United States. Inexpensive electricity produced by the Columbia River dams has encouraged industrialization in the Pacific Northwest, including aluminium plants along the river and aircraft factories in Seattle and other cities in Washington. Irrigation water provided by the dams has turned millions of acres of arid land into a productive farm region.

Commerce. Large ocean vessels travel on the Columbia between the Pacific Ocean and Portland, Oregon. Smaller vessels go from the ocean through the locks of Bonneville Dam and continue up the river to Pasco, Washington. Canals and lock systems also permit barges to use the lower part of the Columbia and sail up the Snake River as far as Lewiston, Idaho. Cargoes transported by barge on the Columbia include grain, forest products, iron and steel products, and petroleum products.

Wildlife of the Columbia River includes such fishes as perch, salmon, and trout. In the Canadian Rockies, forests of fir, larch, hemlock, and spruce trees grow along the river. These mountain areas are the home of bears, bighorn sheep, moose, and timber wolves. Bobcats, coyotes, and elk live in the grasslands that border the river in the United States.

See also **Grand Coulee Dam**; **Gray, Robert**.

Columbine, also called *aquilegia*, is a graceful plant, with about 100 species throughout the Northern Hemisphere. Columbines have five tubular petals with long backward extensions, known as *spurs*. Both the outer protective sepals and the petals are brightly coloured. The leaves are divided into three lobes, which are in turn subdivided.

The common European columbine grows to about 60 centimetres. The flowers have short spurs and may be pink, dull purple, or blue. It grows mainly on chalk and limestone, often near the sea. The common wild columbine of North America bears red and yellow nodding flowers. It grows in rocky woodland areas.

Many cultivated forms of columbine are planted in gardens, including attractive short *alpine* species, which

in the wild grow high up on mountains. Columbine flowers contain a lot of nectar and are pollinated by bees and also by hummingbirds in North America.

Scientific classification. Columbines belong to the buttercup family, Ranunculaceae. The European columbine is *Aquilegia vulgaris*. The common North American columbine is *A. canadensis*.

Columbite is a mineral ore. It is an oxide of niobium, iron, and manganese, and has the chemical formula $(\text{Fe}, \text{Mn})\text{Nb}_2\text{O}_6$. It is the chief source of the element niobium (Nb). Its composition varies greatly, with the element tantalum (Ta) often taking the place of all or part of the niobium. When there is more tantalum than niobium, the mineral is called *tantalite*. Columbite is black, and occurs in blocklike crystals in coarse granite rocks called *pegmatites*. See also **Niobium**; **Tantalum**.

Columbium. See **Niobium**.



The Columbus City Hall stands on the bank of the Scioto River. The statue of Christopher Columbus was given to the city by citizens of Genoa, Italy, the birthplace of the explorer.

Columbus (pop. 632,910; met. area pop. 1,377,419) is the capital city and a leading industrial centre of Ohio, in the United States. It is Ohio's largest city by population and by area. Columbus lies near the centre of Ohio, where the Olentangy and Scioto rivers meet. The city covers 490 square kilometres. The Columbus metropolitan area covers 9,342 square kilometres.

The city provides headquarters for several computer information services. Manufacturers in Columbus produce aeroplanes and car parts, cement mixers, coal mining equipment, electrical appliances, foundry and machine shop materials, and telephone equipment. The city is the home of the Ohio State University, one of the largest universities in the United States.

The Delaware and Wyandot Indians lived in what is now the Columbus area before white settlers first arrived. In 1812, the state legislature chose the site for the capital because it could be reached easily from all major Ohio cities. In 1816, the Ohio state legislature moved to Columbus from Chillicothe, the temporary state capital.



Columbines are attractive plants with nodding flowers. They include the common European columbine, left, and the smaller alpine columbine, right.

Christopher Columbus

1451-1506

S
S A S
X M Y
XPO FERENS.

Signature



Coat of arms



Christopher Columbus has been depicted by many artists over the years. The woodcut on the right is based on a lost painting that dates from 1550. It is considered one of the most accurate likenesses of the explorer. Columbus had a distinctive signature, *above left*, and coat of arms, *above right*.

Woodcut (1575) by Tobias Stimmer; frontispiece in *The Columbus Gallery* by Nestor Ponce de Leon, 1893

Columbus, Christopher (1451-1506), was an outstanding navigator and organizer of expeditions. He achieved fame by sailing west across the Atlantic Ocean in search of a sea route to Asia. But he did not accomplish this goal. Instead, he encountered islands in the Caribbean Sea. At that time, the people of Europe and the Americas did not know of each other's existence. During his four voyages westward—between 1492 and 1504—Columbus explored what are now the West Indies and the coasts of Central and South America.

Columbus was not the first European to reach the Western Hemisphere. The Norse (also called the Vikings) had settled for a time on the coast of North America about A.D. 1000. But that contact did not last, and most Europeans of the 1400's did not know it had taken place. Columbus' voyages led to enduring links between the Eastern and Western hemispheres.

The world of Columbus

The Europe into which Columbus was born in 1451 was struggling against the growing power of the Ottoman Turks, who had conquered much of southeastern Europe. In 1453, the Ottomans took control of Constantinople (now Istanbul, Turkey), a major centre of trade between Europe and Asia. The Ottomans made Constantinople the capital of their empire, cutting off easy European access to Asian goods. The only alternative to a difficult, dangerous land journey was a sea route—either around Africa or westward across the Atlantic.

The desire for a sea route to Asia launched a remarkable wave of exploration. European explorers combined the seafaring skill of the Italians with the resources of the Portuguese and the Spanish. Europe constantly improved its ships and navigational aids, as well as its arms and firepower. Europeans also had other qualities

that encouraged overseas exploration, including a passion for trading and a desire to preach Christianity throughout the world.

Early years

Boyhood. The exact date of Columbus' birth is not known. He was born sometime between Aug. 25 and Oct. 31, 1451, in Genoa, then capital of a self-governing area on the northwest coast of Italy. Genoa was an important seaport, and Genoese ships traded throughout the Mediterranean region.

Christopher's name was *Cristoforo Colombo*. In English, he is known as *Christopher Columbus*, the Latinized form of the name. He called himself *Cristobal Colon* after he settled in Spain. His father, Domenico Colombo, was a wool weaver. Christopher's mother, Susanna Fontanarossa, was the daughter of a wool weaver.

Christopher was the oldest of five children. His brothers, Bartholomew and Diego, worked closely with him on many of his enterprises. Christopher and his brothers may have been tutored or sent to a monastery school to learn basic Latin and mathematics. Christopher's formal education ended at about age 14.

Young adulthood. Christopher's ambitious father pushed the boy into a business career, and Christopher began to sail on trading trips. He worked as an agent for the Spinola, Di Negro, and Centurione families of Genoa. In the mid-1470's, in his first documented voyage, Columbus took part in a trading expedition to the island of Chios, a Genoese possession in the Aegean Sea. In 1476, he settled in a Genoese colony in Lisbon, Portugal. There is a legend that he reached Portugal by swimming ashore clinging to an oar after being attacked by pirates. In Lisbon, Columbus joined with his brother Bartholomew to draw and sell maps.

Columbus frequently attended Mass at a chapel at the Convento dos Santos, a school for aristocratic young women. There, he met Felipa Perestrelo Moniz, whom he married in 1479. Their only child—a son, Diego—was born in 1480. Felipa died in 1484 or 1485.

Between 1480 and 1482, Columbus made voyages to the Canary Islands and the Azores, island groups in the Atlantic Ocean west of Africa. Columbus also visited Portugal's fortified trading posts in western Africa, where he observed the trade in gold and slaves.

The plan to sail westward

The basis of the plan. By the 1480's, the Portuguese had invented the *caravel*, a sturdy ship that could sail against the wind. They were trying to reach the Indies—what are now India, China, the East Indies, and Japan—by sailing around Africa. By doing this, they hoped to gain direct access to gold, silk, gems, and spices. The cloves, nutmeg, and mace of the Spice Islands (now the Moluccas of Indonesia) served as medicines as well as seasonings. These valuable items had been transported to Europe by means of dangerous and costly overland caravans that were often hindered by Ottoman officials. While Portuguese sailors were trying to reach Asia by sailing around Africa, Columbus thought of what he believed to be the easy way—sailing due west.

Many people in the 1400's relied on a map of the world designed by Ptolemy, an astronomer and geographer in Alexandria, Egypt, during the A.D. 100's. Ptolemy's map showed most of the world as covered by land. Columbus found further confirmation for his idea of sailing west to Asia in the letters of Paolo Toscanelli, an influential scholar from the Italian city of Florence. Toscanelli believed that China lay only 5,000 nautical miles (9,300 kilometres) west of the Canary Islands. Columbus planned to sail 2,400 nautical miles (4,500 kilometres) west along the *latitude* (distance from the equator) of the Canaries until he reached islands near Japan. There, he hoped to establish a trading town.

Columbus' plan was based in part on two major miscalculations. First, he underestimated the circumference of the world by about 25 per cent. Columbus also mistakenly believed that most of the world consisted of land rather than water. This mistake led him to conclude that Asia extended much farther east than it actually did.

Presentation of the plan to Portugal. About 1483, Columbus gained audiences with King John II of Portugal. The king placed Columbus' proposal before his council, which rejected it. The council turned down his plan on the belief that he had greatly underestimated the length of the journey. The king's advisers thought that Portugal's resources should be invested in finding a route around Africa to Asia.

Years of waiting. In 1485, Columbus and his son went to Spain, a bitter rival of Portugal. At that time, Spain consisted of the united kingdoms of Castile and Aragon. Columbus arrived during Spain's war to drive the Muslims out of Granada, the only remaining Islamic kingdom on Spanish soil. Two wealthy Spanish aristocrats offered to give Columbus some ships. But to do so, they needed the permission of Spain's King Ferdinand and Queen Isabella. In 1486, Columbus gained an interview with the monarchs, but they were in no position to finance an expedition. They were also cautious about re-

opening conflict with Portugal. Spain and Portugal had recently settled their disputes over various islands off Africa. The Treaty of Alcaçovas, signed in 1479, had conceded the Canary Islands to Spain and the Madeira and Cape Verde islands and the Azores to Portugal.

However, the intensely religious monarchs were interested in how Columbus vowed to use the proceeds from his expedition. He promised to use the money to recapture Jerusalem from the Muslims. There, he said, he would rebuild the Jews' holy Temple and bring on a new "Age of the Holy Spirit." His eloquent arguments gained him support among Franciscan friars and Jews, including Jews who had converted to Christianity.

Queen Isabella admired men of conviction. At her insistence, Columbus' plan was put before a commission of experts. They met in the Spanish cities of Salamanca and Córdoba during 1486 and 1487 under the leadership of Isabella's spiritual adviser, Hernando de Talavera. Although the committee's first report rejected Columbus' plan, Isabella granted him a small salary.

During this period, Columbus lived with a woman named Beatriz Enriquez de Harana. She gave birth to his second son, Ferdinand, in 1488.

In 1490, the experts issued a final report. They scoffed at his plan—not because they thought that the world was flat or sea monsters would devour the ships, but because they still believed his estimates were wrong. The committee favoured the belief that the world was large and covered mostly by water rather than small and composed mostly of land. In addition, Columbus' demands had increased. He wanted to become a titled aristocrat, to rule the lands he discovered, and to be able to pass these privileges on to his sons. He also wanted a percentage of the wealth he brought back to Spain.

Success in Spain. Columbus refused to give up. He sent his brother Bartholomew to seek support from the English and French courts, but the attempts were unsuccessful. Columbus' chance finally came when Spain conquered Granada in January 1492. In the aftermath of this victory, Luis de Santangel, a royal treasurer, convinced Isabella that she was missing a great opportunity. Thus, in April 1492, Columbus' plan suddenly received royal approval. Columbus' supporters—including Santangel, who ran a government agency that had extra money in its treasury—provided the funds for the expedition.

First voyage westward

Ships and crews. Palos, a small port in southwestern Spain, was home to the Pinzón and Niño families. They provided two of the ships and selected the crews for Columbus' first voyage. Martin Alonso Pinzon, an experienced seafarer, captained the *Pinta*, a caravel with square-rigged sails that could carry about 54 metric tons. His brother, Vincente Yáñez Pinzón, captained the slightly smaller *Niña*, a caravel with *lateen* (triangular) sails. Columbus captained the third vessel, the *Santa María*. It was chartered from Juan de la Cosa, who came along as sailing master. It was slightly bigger than the other two ships. All three were made of wood, had no engines or motors, and provided few comforts.

A total of about 90 crew members sailed aboard the three ships. In addition to the officers and sailors, the expedition included a translator, three doctors, servants for each captain, a secretary, and an accountant.



Columbus' three ships from his first voyage westward were re-created to commemorate the 500th anniversary of his landing. Leading the procession is the reconstructed *Niña*, followed by the *Pinta* and the *Santa Maria*

The crews cooked on portable wood-burning stoves. Their main meal consisted of a stew of salted meat or fish, hard biscuits, and watered wine. The sailors had no sleeping quarters, so they huddled on deck in good weather or found a spot below deck during storms. Only a few officers had bunks.

Sailing west. The fleet set out from Palos on Aug. 3, 1492, and sailed to the Canary Islands. Repairs were made on the island of Grand Canary, and the crews loaded provisions on the island of Gomera. The ships left Gomera on September 6. Because he had journeyed

south before sailing west, Columbus could take advantage of the trade winds. At that latitude, these winds always blow from the northeast.

Columbus had few navigational instruments. He knew enough about celestial navigation to measure latitude by using the North Star. However, he had no instruments for determining the ship's position from the stars except a crude quadrant that was not accurate when the ship rolled. He used a compass to plot his course, estimated distances on a chart, relied on a half-hour glass to measure time, and guessed his speed. Together, these

Columbus' first voyage westward

On Aug. 3, 1492, Columbus sailed from Spain in search of a route to the Indies across the Atlantic Ocean. On October 12, he reached an island that he called San Salvador. For many years, historians believed that Columbus' first landing took place on present-day San Salvador, shown on the map below. But today, scholars do not agree on the exact site of this landing





Detail of *Landing of Columbus* (1844) by John Vanderlyn

Columbus first landed in the New World on Oct. 12, 1492. He went ashore on San Salvador Island in the Bahamas and claimed possession for Spain.

activities make up a method of navigation known as *dead reckoning*.

After a month of smooth sailing, the crews became anxious that they had not yet reached the islands Columbus had led them to expect. There was no full-fledged mutiny, but only the authority of the Pinzón brothers enabled Columbus to calm the crews' loudly expressed doubts. Then, signs of approaching land began to appear, such as coastal seaweed on the surface of the water and land-based birds flying overhead.

Between the evening of October 11 and the morning of October 12, a sailor on the *Pinta* named Juan Rodríguez Bermejo called out, "Land, land!"

The first landing. Before noon on October 12, the ships landed on an island in the Caribbean Sea, in what are now called the West Indies. Columbus named the island *San Salvador* (Spanish for *Holy Saviour*). He later learned that inhabitants of the area called the island Guanahani. However, historians are not sure which island this is. In 1926, Watling Island in the Bahamas was officially renamed San Salvador Island because Columbus scholars considered it the most likely landing site. Other islands where he might have landed include Samana Cay and Conception in the Bahamas, and Grand Turk in the Turks Islands.

Columbus believed he had arrived at an island of the East Indies, near Japan or China. Because of this belief, he called the islanders *Indians*. People realized within 30 years that Columbus had not reached the Indies, but the name *Indian* continued to be used.

The islanders were probably the Taino, a subgroup of the Arawak people. They were skilled farmers who made cotton cloth, grouped their dwellings into villages, and had well-developed social and governmental systems. Columbus described them as gentle, "primitive" natives living in an island paradise. This description set the pattern for European attitudes toward the Western Hemisphere, despite later knowledge of the highly advanced Aztec of Mexico and Inca of Peru.

On October 28, the fleet entered the Bay of Bariay off

Cuba. Thinking they were near the Asian mainland, the captains explored harbour after harbour. They sailed along the northern coast of the island of Hispaniola, now the Dominican Republic and Haiti. Columbus called it *La Isla Española* (the Spanish Island).

On the night of December 24, the *Santa Maria* crashed and split apart on a reef near Cap-Haïtien, in present-day Haiti. Aided by a local chief, the crew built a makeshift fort. Columbus left about 40 men there to hunt for gold. He then started home on the *Niña*, sailing from Samana Bay on the northeast coast of Hispaniola on Jan. 16, 1493. He brought several captured Tainos with him. Martín Pinzón captained the *Pinta*.

Return to Spain. The homeward voyage was rough and difficult. Some of the Tainos died. After about a month of travel, the *Niña* and the *Pinta* became separated during a storm. The *Niña* came ashore on the Portuguese island of Santa Maria in the Azores. Columbus and his crew were almost arrested by the governor, who assumed they had been trading illegally in Africa. Columbus set out again, but storms forced him to seek shelter in Lisbon. The *Niña* finally reached Palos on March 15, 1493.

Columbus had been concerned that Martín Pinzón would reach Spain first and claim the glory. Indeed, Pinzón had reached a small village in Spain a few days earlier and had notified the monarchs of his arrival. However, they refused to see him until they had heard from Columbus. The *Pinta* arrived at Palos a few hours after the *Niña*.

Columbus reported to Ferdinand and Isabella at Barcelona, Spain, where they gave him a grand reception. Columbus had little to show except some gold trinkets and the few Tainos who survived the harsh trip, but the monarchs determined to exploit his find. They quickly applied to Pope Alexander VI for control over the lands visited so far, and also of all lands west of a line 100 leagues (about 300 nautical miles, or 560 kilometres) from the Azores. The pope granted Ferdinand and Isabella the right to preach the Christian faith in the islands, and they used this right as the basis for sweeping claims over the lands. However, Portugal complained that these terms violated an earlier treaty.

In 1494, negotiations opened in the town of Tordesillas in Spain. Spain and Portugal eventually agreed to move the line to 370 leagues (about 1,100 nautical miles, or 2,060 kilometres) west of the Cape Verde Islands. This later enabled Portugal to claim Brazil and the Newfoundland Banks. See **Line of Demarcation**.

Second voyage westward

Return to the islands. Columbus was put in charge of 17 ships for a second voyage. The all-volunteer crew of about 1,200 to 1,500 men included colonists who intended to settle in the islands. Priests went along to try to convert the Indians to Christianity.

The fleet sailed from Cádiz, Spain, on Sept. 25, 1493. It took on supplies in the Canaries and completed the ocean crossing in a speedy 21 days. In another three weeks, the ships reached Hispaniola. They passed many islands. Columbus named one of them—present-day Marie-Galante in the French West Indies—after his flagship. Columbus also landed briefly at Puerto Rico, the only part of what is now the United States that he visited.

Trouble, settlement, and exploration. In Hispaniola, Columbus searched in vain for the sailors he had left at the fort. The survivors had probably been killed by the Tainos, whom they had mistreated.

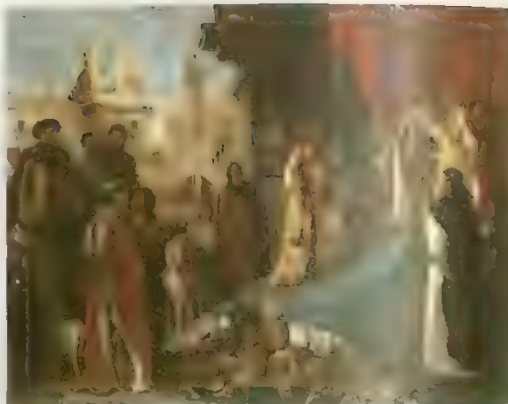
Columbus moved eastward along the north coast of Hispaniola and established Isabela, a fortified post. There, the Spanish colonists quickly saw that the riches promised by Columbus would not materialize. They resented being given orders by a Genoan rather than a Spaniard, and some fell ill from tropical fevers. Shortly after their arrival, 12 of the 17 ships returned to Spain with orders to bring more supplies to Isabela. The ships also carried discontented colonists back to Spain. To prevent rebellion, and also to make the voyage produce a quick profit, Columbus sent some men into the interior of Hispaniola to search for a gold mine.

Leaving his brother Diego in charge, Columbus left Isabela during the spring of 1494 to explore the southern coast of Cuba (which he called *Juana*). After traveling down its long coastline, Columbus declared that it was the Asian mainland. Although this was not so, he forced the crews to sign an affidavit saying they agreed with him. Columbus also landed at Jamaica.

When Columbus returned to Hispaniola, he found his brother Bartholomew waiting for him. Columbus immediately appointed Bartholomew provincial governor of Hispaniola. This appointment angered many of the Spanish settlers. In addition, they complained about having only cassava (tapioca), maize, fish, and yams to eat.

The Tainos had begun to suffer and die from infectious diseases brought over unintentionally by the Europeans, and food had become scarce. Columbus forced all male Tainos over age 14 to pan rivers for gold. Those who failed to collect an assigned quota of gold were punished, sometimes by having their hands cut off. The quotas were almost impossible to meet. When the Indians threatened to rebel, Columbus used their rebellion to justify enslaving them.

In Spain, the priests and Spanish colonists who had



The Return of Christopher Columbus from the New World (1839), an oil painting on canvas by Eugène Delacroix; The Toledo Museum of Art, Toledo, Ohio, U.S.A.

Columbus returned to Spain on March 15, 1493. He later reported his findings to King Ferdinand and Queen Isabella, above. They gave him the titles *Admiral of the Ocean Sea* and *Viceroy of the Indies* and ordered a second voyage.

left Isabela in the early months of 1494 complained to Ferdinand and Isabella about conditions in Hispaniola. The priests criticized the maltreatment of the Tainos, and the colonists charged Columbus with misgovernment in the colony. Columbus decided to return to Spain to defend himself, arriving in June 1496. Again, Columbus' powerful oratory and impressive presence succeeded. The king and queen reconfirmed his titles and privileges, and they granted his request for additional men, supplies, and ships. But few men wanted to sail with him this time because the islands had failed to yield the expected profit. To assemble crews, Ferdinand and Isabella had to pardon prisoners. Columbus' sons, who served as pages at court, were mocked by other boys. They jeered, "There go the sons of the Admiral of the Mosquitoes."

Columbus' voyages of exploration

Columbus made four voyages westward between 1492 and 1504. He explored the coasts of Cuba, Hispaniola, Jamaica, and Puerto Rico on the first and second voyages. Columbus reached the mainland of South America on the third and fourth voyages.

- First Voyage 1492–1493
- Second Voyage 1493–1496
- Third Voyage 1498–1500
- Fourth Voyage 1502–1504

0 500 Miles
0 500 Kilometers



Third voyage westward

Third journey to the west. On May 30, 1498, Columbus departed from Sanlúcar, Spain, with six ships. He charted a southerly course. Ferdinand and Isabella wanted Columbus to investigate the possibility that a mainland lay south or southwest of the lands he had already explored. The possibility that such a mainland existed had been accepted by the king of Portugal, and Spain wanted to stake its claim.

The fleet ran into a windless region of the ocean and was becalmed in intense heat for eight days. It reached an island Columbus called *Trinidad* (meaning *Trinity*) on July 31 and then crossed the Gulf of Paria to the coast of Venezuela. Columbus observed an enormous outflow of fresh water—later found to come from the Orinoco River—that made him realize this land could not be an island. He wrote in his journal: "I believe that this is a very great continent which until today has been unknown."

Some scholars believe that while in Spain, Columbus had heard of English-sponsored landings in Nova Scotia and Newfoundland in 1497 by Italian explorer John Cabot. The news may have made Columbus think he might not have reached Asia. He did not mention his doubts, wanting to first explore and claim the land for Spain. For this reason, instead of being named after Columbus, the American continents were named after Amerigo Vespucci, an Italian navigator. A few years later, in a document backdated to 1497, the claim was made that Vespucci had been the first to explore the mainland, believing he had reached a "New World."

Problems in Hispaniola. Columbus found the Hispaniola colony seething with discontent. He tried to quieten the settlers by giving them land and letting them enslave the Indians to work it, but that failed to satisfy many. A rebellion had been led by the chief justice, Francisco Roldán. For a time, Roldán and the Tainos—with whom he had established an alliance—held part of the island. Columbus managed to subdue the rebellion through negotiation and a show of force.

Columbus in disgrace. By 1500, many complaints about Columbus had reached the Spanish court. Ferdinand and Isabella sent a commissioner named Francisco de Bobadilla to investigate. Upon arrival in Santo Domingo—the capital of Hispaniola—in August 1500, Bobadilla was shocked by the sight of several Spanish rebels swinging from gallows. He freed the remaining prisoners, arrested Columbus and his brothers, put them in chains, and sent them to Spain for trial. Once at sea, the captain of Columbus' ship offered to unchain him. But Columbus refused, saying he would only allow the chains to be removed by royal command.

In Spain, Columbus and his brothers were released by order of the king and queen. The rulers forgave Columbus, but with conditions. Columbus was allowed to keep his titles, but he would no longer be permitted to govern Hispaniola. Nicolás de Ovando was sent to serve as governor of Hispaniola, with about 30 ships carrying 2,500 colonists.

Fourth voyage westward

The final voyage. Columbus planned still another journey, which he called the "High Voyage." He saw it as

his last chance to fulfil the promise of his earlier expeditions. His goal was to find a passage to the mainland of Asia. Columbus still believed that China lay close by. Ferdinand and Isabella granted his request for ships because they wanted to get him out of the way. But they instructed him not to stop at Hispaniola unless absolutely necessary to get supplies, and then only in preparation for his return to Spain.

On May 9, 1502, Columbus set sail from Cadiz, Spain, with four ships. Columbus' son Ferdinand, about 14 years old, sailed with his father. Ferdinand's account of the trip, though written many years later, remains the best record of the voyage. The fleet stopped briefly at the Canary Islands, then sailed to Martinique—in what is now the French West Indies—in just 21 days. It then headed toward Hispaniola.

A dangerous hurricane. Governor Ovando was sending 21 ships to Spain when he received a message from Columbus warning of an impending storm and asking permission to land. Feeling contempt for Columbus, and reminding him that he was forbidden to land at Hispaniola, Ovando ignored the warning and sent his ships to sea. Columbus' fleet weathered the storm. However, all but one of Ovando's ships sank in a hurricane. Columbus' enemies Bobadilla and Roldán drowned. The ship that reached Spain was the one carrying Columbus' share of the gold collected in Hispaniola, and the personal possessions he had left there.

Further explorations. At the end of July, Columbus and his fleet reached the coast of Honduras. For the rest of the year, they sailed east and south along the coasts of what are now Honduras, Nicaragua, Costa Rica, and Panama. The ships were battered by rough winds and driving rains.

At the narrowest part of the Isthmus of Panama, Columbus heard tales that a large body of water lay a few days' march across the mountains. But he did not follow up on this information, so he missed a chance to become the first European to see the Pacific Ocean. Columbus abandoned his search for a passage to Asia on April 16, 1503. He was exhausted and suffering from malaria, which made him delirious.

The hard journey home. Columbus' fleet had to move slowly, because his ships were leaking badly from holes eaten in the planking by shellfish. On June 25, the two remaining ships had to be beached at St. Ann's Bay, which Columbus had called Santa Gloria, on the northern coast of Jamaica.

Columbus realized that the chances were slim that another expedition would arrive to rescue him and his crew. Captain Diego Mendez volunteered to try to get help by paddling to Hispaniola in an Indian dugout canoe. Mendez reached Hispaniola, but Ovando refused to provide a ship until more vessels arrived from Spain.

The crews had no tools to repair the ships or to build new ones, and they made no effort to feed themselves. Instead, they relied on the islanders to provide food. The Jamaicans started avoiding them. Columbus later claimed that he used information from an almanac to predict a total eclipse of the moon, which so impressed the islanders that they resumed providing food.

At last, at the end of June in 1504—after being marooned for a year—Columbus and the 100 surviving crew members sailed from Jamaica on a ship chartered

by Mendez. They reached Sanlúcar, Spain, on Nov. 7,

Final days

Queen Isabella died just a few weeks after Columbus returned to Spain. King Ferdinand granted Columbus an audience and listened to his requests. However, Ferdinand tried to persuade Columbus to trade in the rewards and privileges due him in exchange for an estate in north-central Spain. Columbus, in turn, tried to persuade Ferdinand to restore his authority and increase his income, but these requests were not granted.

Columbus spent his last days in a modest house in Valladolid, Spain, suffering from a disease that may have been Reiter's syndrome. On May 20, 1506, at the age of 54, Columbus died.

Columbus' remains were transported to Seville, Spain, and later to Santo Domingo, in what is now the Dominican Republic. Some historians believe that his bones were moved to Havana, Cuba, in 1795, and, finally, back to Seville in 1899. Other historians believe that the bones of one of Columbus' brothers or of his son Diego were removed from Santo Domingo instead, and that Columbus' final resting place is Santo Domingo.

Columbus' impact on history

Christopher Columbus had a strong will and stuck with his beliefs. His single-minded search for a westward route to Asia changed Europeans' commonly accepted views of the world and led to the establishment of contact between Europe and the Americas.

Many exchanges took place between the Eastern and Western hemispheres as a result of Columbus' voyages. The Europeans grew important cash crops—cotton, rubber, and sugar cane—in the Americas. They established vast plantations worked by Indians and by imported African slaves. They also obtained furs and precious metals. These valuable resources created fortunes for the Dutch, English, French, Portuguese, Russians, and Spanish. The wealth and human resources of the Western Hemisphere gave these countries a huge advantage over the rest of the world in later centuries.

Europeans brought many deadly diseases to America. The previous separation of the Native American peoples from those of Europe and Asia meant that the Native

Americans had no resistance to these diseases. As a result, malaria, measles, smallpox, tetanus, typhus, and other infectious diseases swept through the newly exposed populations, killing vast numbers of people. In turn, some Europeans became infected by a form of syphilis unknown in Europe.

The love of freedom and the sharing of leadership among the Native American populations inspired a new belief in personal liberty among Europeans. This belief became a basis for democratic revolutions against European monarchies and greatly influenced the structure of government in the United States.

The Americas also provided many foods that became popular throughout the world. These foods included cassava, cayenne, chocolate, hot peppers, paprika, peanuts, sweet potatoes, tomatoes, and white potatoes. Europe and Asia, in exchange, supplied the Americas with cattle, goats, honey bees, horses, pigs, rice, sheep, wheat, and many trees and other plants.

Recent research into the life and times of Christopher Columbus has somewhat diminished his heroic image as an isolated visionary by placing him in the context of a broad wave of exploration. Historians continue to praise his persistence, courage, and maritime ability. Critics point to his cruelty to the Indians, his poor administration of Hispaniola, and his role in beginning the heedless exploitation of the natural resources of the Americas. Columbus' explorations ended centuries of mutual ignorance about what lay on either side of the Atlantic Ocean. To him belong both the glory of the encounter and a share of the blame for what followed.

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| Ferdinand V | Virgin Islands (Exploration) |
| Haiti (History) | |

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| B. Presentation of the plan to Portugal | D. Success in Spain |

Oil painting on canvas (about 1880) by Lorenzo Delleani: Galleria d'Arte Moderna, Genoa, Italy



A chained Columbus was sent back to Spain in 1500. The ship's captain offered to free him, but Columbus refused, saying he would only allow the chains to be removed by royal command.

IV. First voyage westward

- A. Ships and crews
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VIII. Final days

IX. Columbus' impact on history

Questions

- On what two miscalculations did Columbus base his plan to sail westward?
- What is the only part of the present-day United States that Columbus visited?
- What is *dead reckoning*?
- How did the Ottoman take-over of Constantinople in 1453 affect trade between Europe and Asia?
- What exchanges took place between the Eastern and Western hemispheres as a result of Columbus' voyages?
- What made Columbus realize he might not have reached Asia?
- Did Spain restore Columbus' authority after the fourth voyage?
- Where might Columbus' first landing in the Western Hemisphere have taken place?
- Why did Columbus call the islanders he encountered *Indians*?
- What happened to the first settlement at Hispaniola?

Column is a freestanding vertical architectural element. When used for structural purposes, columns are often arranged in rows to permit the thickness of walls to be reduced by supporting weight from above. Some columns, erected for decorative or memorial purposes, stand alone. Columns are constructed of various materials, including wood, stone, brick, metal, and concrete.

A typical column consists of three parts: base, shaft, and capital. The base is the lowest part of the column. It supports the central upright shaft, which is usually cylindrical. The shaft is crowned by the capital. The horizon-

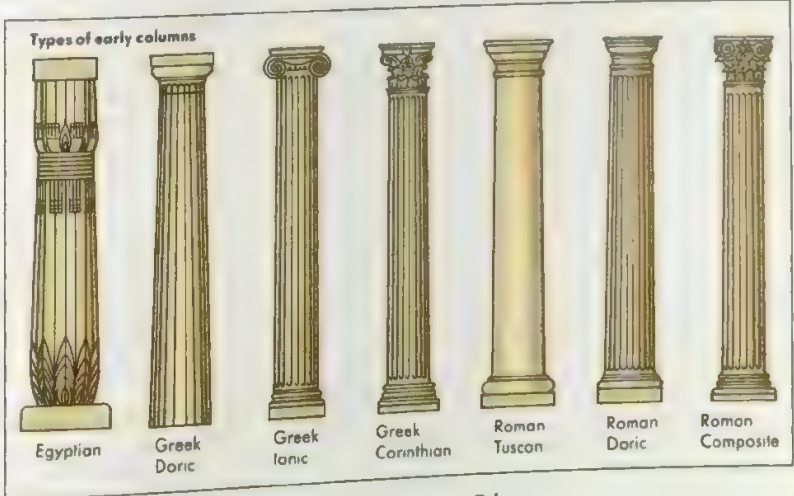
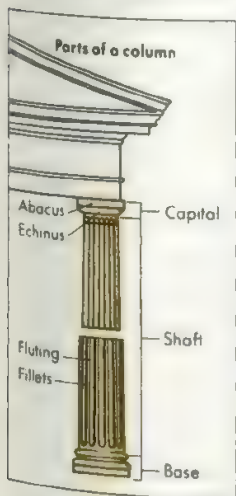
tal area above the column and supported by it is called the *entablature*. The base, column, and entablature together compose an *order* (see **Architecture** [Architectural terms]). Through the centuries, architects have used various kinds of columns. The ancient Egyptians favoured heavy, massive columns, such as the central pillars of the Great Hall in the temple at Karnak. The Persian column was generally tall and slender.

The Greek orders. The ancient Greeks refined the column to a high degree. They developed three basic classical orders—Doric, Ionic, and Corinthian. The shaft diameter of each type of column decreases gradually as the shaft rises, and each type has a subtle outward curve called *entasis*.

The Doric column is the oldest and simplest of the three types. It developed primarily on Greece's mainland and in its western colonies. The Doric style has no base. Usually, the shaft tapers upward to a height of 5 to 7 times its lower diameter. Along the shaft, 16 to 20 shallow vertical grooves called *flutes* meet in sharp ridges. One or several horizontal grooves, called *necking*, mark the meeting of the shaft and the capital. The capital has two parts of almost equal thickness. The upper, a flat square block called the *abacus*, rests on a round pillow-like tablet called the *echinus*. A celebrated building using the Doric order is the Parthenon, on the Acropolis of Athens (see **Parthenon**).

The Ionic column is more slender and decorative than the Doric. It was invented by the Greeks of the Aegean Islands and Asia Minor. The Ionic shaft stands on a circular base, which sometimes includes a square block at the bottom called a *plinth*. Its height is usually 9 to 10 times its lower diameter. Ordinarily, 24 flutes—divided by narrow *fillets* (flat surfaces), run along the shaft. The capital consists of *volute*s (scrolls) that separate the echinus from the abacus. Ionic columns stand in the Erechtheum at Athens (see **Acropolis**).

The Corinthian column is the most ornamental of the Greek orders. A variation of the Ionic, it has a similar fluted shaft, but it has a more elaborate capital. The capital consists of a central core resembling an inverted bell.



A **column** is a vertical support that consists of a shaft and a capital and often rests on a base. Columns created by the ancient Egyptians, Greeks, and Romans greatly influenced later architecture.

The core is surrounded by carvings of acanthus leaves arranged in rows. From these leaves, four volutes project to meet the corners of the abacus. The monument of Lysikrates at Athens has Corinthian columns.

The Roman orders. The ancient Romans based their column designs on those of the Greeks. They also created two new orders—the Tuscan and the Composite. The Roman Doric order resembles the Greek but adds a simple moulded base. The Tuscan order is a version of the Doric without flutes. The Romans adopted the Greek Ionic with little change, but they elaborated and enriched the Corinthian. The Composite order combines features of both the Ionic and the Corinthian.

The Romans also erected independent, isolated columns as memorials to famous persons and events. Sculptors decorated many of these massive, towerlike columns with carved or moulded horizontal or spiralling bands called *friezes* that portray events related to the memorial. An example is Trajan's Column in Rome.

Columns of later periods. During early Christian and medieval times, architects freely adapted the classical orders for use in basilicas and cloisters. The Cathedral of Notre Dame in Paris has a combination of classical and medieval styles. The Renaissance and baroque periods revived the use of Roman-style columns, as in the colonnades of St. Peter's Square in Rome. In the 1800's and 1900's, all types of columns have been used.

See also *Architecture; Pompeii; Rome*.

Colwyn (pop. 54,600) is a local government district in western Clwyd in Wales. It is administered from the town of Colwyn Bay. Inland, farming and forestry are the main industries. Along the coast, holiday resorts such as Colwyn Bay and Abergelge attract many visitors. Abergelge is also a market town. See also *Clwyd*.

Coma is a state of deep and complete loss of consciousness. The word comes from the Greek word *koma*, meaning *deep sleep*. Persons in this state ordinarily cannot be aroused by stimulants such as spirits of ammonia, light slapping, or a pinprick. Drug overdoses, seizures, head injuries, tumours, and strokes may cause coma. Patients with diabetes or diseases of the liver or kidneys can also fall into a coma. Doctors treat coma according to its cause.

Combination Acts. See *Trade unions*.

Combinations. See *Permutations and combinations*.

Combine harvester is a farm machine that cuts and threshes grain or other crops in one operation. Some are large, self-powered machines. Others are smaller models pulled by tractors. Large combine harvesters cut paths wider than 6 metres. Small ones cut paths up to about 2 metres wide. Those with special attachments can collect and shell maize, soybeans, and other crops.

As a combine harvester moves across a field, a *cutting bar* on the front cuts the stalks of grain. Paddles on a long, rotating reel press the stalks against the cutting bar. The cut stalks fall onto a platform, and a *feeder* carries them to a *threshing drum*. Inside the drum, a revolving cylinder beats most of the grain off the stalks, creating straw. The grain falls through a grate into a *grain pan*. The straw is tumbled to remove any remaining grain. The straw then drops from the machine.

All the grain collects in the grain pan. From there, it passes to a series of sieves, where a fan blows the husks away from the kernels. The kernels fall through the

sieves and are carried to temporary storage in a *grain tank*. Finally, an *unloading conveyor* empties the grain from the grain tank into lorries or carts.

One of the first successful combine harvesters was built in the 1830's by Hiram Moore and John Haskell in Michigan, U.S.A. It was pulled by 20 horses. A wheel that rolled along the ground drove the cutting and threshing machinery. In the 1880's, steam engines began to power combine harvesters. Internal-combustion engines were replacing steam engines by the early 1900's.

Before the arrival of combine harvesters farmers used reapers and threshing machines, which required more time and labour (see *Reaper; Threshing machine*). After World War I ended in 1918, new designs of combine harvesters, plus a labour shortage in many countries, caused more farmers to use combines. Since then, combine harvesters have replaced most reapers and threshing machines.

Combustion is a chemical reaction that gives off heat and light. In most cases, combustion involves the rapid combination of oxygen with a fuel to produce burning. The fuel may be solid, liquid, or gaseous. Combustion occurs, for example, when oxygen in the air reacts with the charcoal in a barbecue grill. In some cases, such chemicals as fluorine or chlorine take the place of oxygen in the combustion process. When oxygen combines slowly with another substance, the reaction is usually called *oxidation*. The rusting of iron is an example of oxidation. See *Oxidation; Oxygen*.

In most cases, combustion occurs between a gaseous fuel and the oxygen in the air. The fuel may begin as a solid or liquid, but it must be *vaporized* (changed to a gas) before it can burn. The lowest temperature at which a solid or liquid produces enough gas for combustion is called its *ignition temperature*. The energy given off by burning fuel is called the *heat of combustion*. It is usually measured in calories per gram (see *Calorie*).

Sometimes, a substance suddenly ignites. This is called *spontaneous combustion*. It occurs when chemical reactions within the substance produce heat that cannot escape. The substance slowly reaches its ignition temperature and begins to burn. Spontaneous combustion may occur when piles of oily rags, coal, or cotton are left unattended.

See also *Dust explosion; Fire*.

COMECON. See *Common market*.

Comedy is a form of drama that deals with humorous or ridiculous aspects of human behaviour. Most comedies have a playful mood and end happily.

There are many types of comedy. The three most common ones emphasize character, ideas, or situations. In *comedies of character*, the humour comes from the major traits of the characters. *Comedies of ideas* deal chiefly with social issues. *Situation comedies* rely on comic actions and events. Other important types of comedy include *comedies of manners* and *romantic comedies*. Most comedies of manners are humorous treatments of the social codes of the upper and middle classes. Most romantic comedies concern people who are in love. An exaggerated kind of comedy called *farce* is sometimes considered a separate type. But farce may be treated as a form of situation comedy.

The first important comic playwright was Aristophanes, who lived in Greece from about 445 to 385 B.C.



Comedy called farce deals in an exaggerated way with ridiculous situations. *Charley's Aunt*, above, is a classic English farce.

Most of his comedies deal with public issues. The ancient Roman playwrights Plautus and Terence wrote situation comedies based on events from everyday life.

During the Middle Ages, farce was the major type of comedy. In the late 1500's and early 1600's in England, William Shakespeare wrote plays involving almost every type of comedy, while Ben Jonson specialized in satiric comedies of character, with each character dominated by a single trait, such as greed. In the mid-1600's, Molière became the most famous comic playwright in France, with plays similar to Jonson's. In the late 1600's, English playwrights William Wycherley and William Congreve raised the comedy of manners to a high level.

Many playwrights of the 1700's wrote sentimental comedies. These dramatists included Sir Richard Steele of England and Pierre Marivaux of France. Later in the 1700's, witty comedies were written by Oliver Goldsmith of Ireland, by Richard Brinsley Sheridan of England, and by Pierre de Beaumarchais of France.

In the early 1900's, the Irish-born dramatist George Bernard Shaw proved a master of the comedy of ideas, which discusses moral or philosophical issues without interrupting the humour. Noel Coward wrote comedies of manners about England's sophisticated society.

During the mid-1900's, the Irish-born playwright Samuel Beckett and Romanian-born Eugène Ionesco pioneered the theatre of the absurd, in which bizarre comic events mingled with serious action. The *dark comedies* of Harold Pinter in England and Edward Albee in the United States are an offshoot of this school. In the late 1900's, Alan Ayckbourn in England and Neil Simon in the United States have specialized in situation comedies about everyday life.

See also **Burlesque**; **Drama**; **Film industry**; **Humour**.
Comedy of manners. See **Comedy**; **Drama** (European drama); **English literature** (Restoration drama).
Comenius, John Amos (1592-1670), was a Czech educational reformer and religious leader. He criticized the educational conditions of his time and called for a reorganization of schooling.

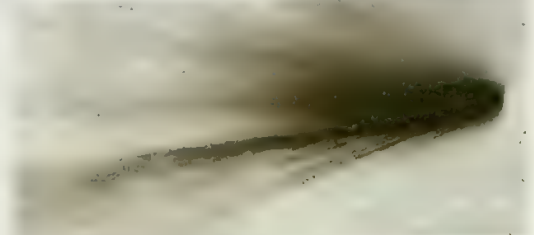
Comenius described his educational system in a book called *Didactica Magna* (*The Great Didactic*), which he finished about 1635. He proposed that education be organized in graded stages, from easy to difficult. He also called for teachers to use kindness instead of harsh discipline and to teach certain classes in their students' native language rather than Latin.

Comenius, whose Czech name was Jan Amos Komenský, was born in Uherský Brod, near Zlín, in what is now the Czech Republic. He wrote in Latin and used a Latin name. About 1616, he was ordained a pastor in a Protestant group called the Brethren, now the Moravian Church. Comenius became a bishop in 1648.

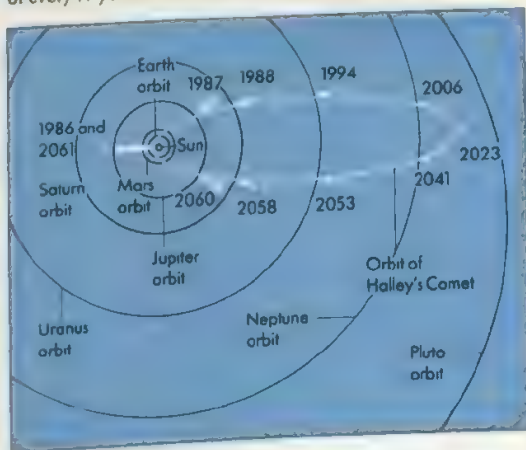
Comet is an object that resembles a fuzzy star and travels along a definite path through the solar system. Some of the brightest comets develop a long, shining tail when they come near the sun. The tail of a comet may stream across space as far as 160 million kilometres. A comet has a distinct centre called a *nucleus* that measures less than 16 kilometres in diameter. A hazy cloud called a *coma* surrounds the nucleus. Its diameter may be as large as 1.5 million kilometres. The coma and nucleus make up the comet's head.

Most comets cannot be seen without a telescope. Some are visible to the unaided eye, but only for several weeks or months when they pass closest to the sun. Halley's Comet is probably the best-known comet. It was named after the English astronomer Edmond Halley, who recognized that it could be seen an average of every 77 years. The comet was seen twice in the 1900's—in 1910 and in 1986.

A number of other extremely bright comets have been seen since 1910. For example, Comet Arend-Roland and Comet Mrkos appeared in 1957 and Comet Ikeya-Seki in 1965. In 1973, Comet Kohoutek became the first comet to be studied by men in space. Astronauts in



Halley's Comet becomes visible to the unaided eye an average of every 77 years when it nears the sun.



A comet travels through the solar system in a long, narrow orbit. The orbit of Halley's Comet, shown in the diagram above, crossed the orbit of the earth in 1986, and astronomers predict that it will do so again in 2061.

the Skylab space station photographed it and so provided much new information about comets.

For centuries, many people believed the coming of a comet would bring a disaster, such as a war or an epidemic. Halley's Comet revived these fears in 1910. Later, many people thought it predicted the outbreak of World War I in 1914. This fear had no scientific basis. However, a collision between the earth and a comet's nucleus could be very destructive.

The composition of comets. Scientists once believed the nucleus of a comet consisted of tiny solid particles held together loosely by gravitation. Today, most astronomers think the nucleus resembles a dirty snowball that was formed in the cold, distant regions of the solar system. The nucleus probably consists of frozen gases and ice mixed with dust. The gases include ammonia, carbon dioxide, carbon monoxide, and methane. The gases and water make up 70 to 80 per cent of the total mass. The remaining 20 to 30 per cent may resemble meteoric particles. This portion consists of fine grains and larger chunks of metals and rocky material.

As a comet approaches the sun, the heat causes the outer layers of the icy nucleus to evaporate. The evaporation releases dust and gases, which form the coma around the nucleus. The pressure of the sun's light may push the smallest dust particles and gas molecules away from the coma, forming one or more tails. This pressure makes a comet's tail point away from the sun. When a comet approaches the sun, its tail brings up the rear. But when the comet moves away from the sun, its tail leads.

All of a comet's light comes from the sun. The brightness of a comet results partly from sunlight reflected by its nucleus and coma. In addition, when a comet is closest to the sun, gas molecules in the coma release energy absorbed from the sun's rays.

The paths of comets. Most comets travel around the sun in *elliptical* (oval-shaped) paths. The time it takes a comet to make a complete orbit is called its *period*. Some comets have short periods of less than seven years. Others travel in such huge orbits that they pass near the sun only once in thousands or even millions of years. These *long-term* comets travel many millions of

kilometres beyond the outermost planets before eventually returning to pass by the sun. All comets seen by astronomers are considered part of the solar system.

See also **Halley's Comet**; **Moon** (The moon's surface). **Comfrey** is a bushy perennial plant found in Europe and Asia. It has large lance-shaped leaves and clusters of bell-like flowers that may be cream, blue, mauve, purple, pink, or crimson. The flowers are attractive to bees. The whole plant is covered in pale bristly hairs that are rough to the touch. Comfrey is found in damp places such as river banks and grows up to 1 metre high. It grows from a thick fleshy root.



Comfrey

The common comfrey is a medicinal plant. It is used to help heal wounds. The root is peeled and mashed into a pulp before being applied to the wound.

Scientific classification. Comfrey belongs to the family Boraginaceae. The common comfrey is *Symphytum officinale*.

Comic opera. See **Opera** (Baroque opera).

Comics are a series of related cartoons that tell a story. A comic may be a picture strip, with words. The word comic can also mean a magazine, usually for children, containing such strips and other features. Most comic strips appear in newspapers. A comic may tell part of a continuing story, or it may be a complete story in itself. A majority of comics feature a continuing cast of characters. In most comics, conversation between the characters appears near their heads in white areas called *balloons*. A few comics, called *pantomime strips*, have no conversation at all.

The main purpose of comics is entertainment. Most early comics used humour. Today, many comics are based on humour, but others tell exciting adventure and fantasy stories. Still others describe dramatic events in the lives of such people as doctors, police officers, reporters, and secretaries. Some comics retell Bible stories and historical tales, or offer adaptations of classics of literature, such as the plays of William Shakespeare. Teenage readers enjoy magazines which feature comic strip stories dealing with romance and personal problems of concern to teenagers, and which also have articles about pop stars.

Surveys show that comic strips are the most popular feature in newspapers. Some strips, such as Charles Schulz's "Peanuts," appear in over 2,000 newspapers. In addition, millions of comic books are sold annually.

The popularity of comics has made comic characters a useful tool in advertising. Many companies use comics or comic characters to promote their products. Comics are also used in educational publications.

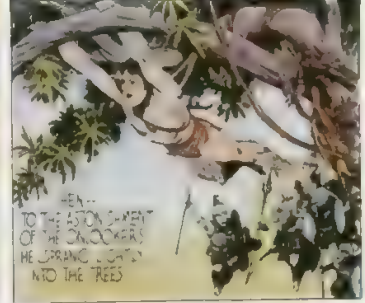
Comics have inspired books, films, plays, songs, and radio and television programmes. Comics have even influenced a movement in the fine arts called pop art.

How comics are created. Most comic strips are the work of one person who does both the drawing and writing. But some strips are produced by two or more people. In many cases, a writer works out the story, and

Famous comets

Name	First seen	Period of orbit (Years)
Halley's Comet	Before 240 B.C.	76-79*
Tycho Brahe's Comet	1577	Unknown
Biela's Comet	1772	6.6-6.8*
Encke's Comet	1786	3.3
Comet Flaugergues	1811	3,000
Comet Pons-Winnecke	1819	5.6-6.3*
Great Comet of 1843	1843	513
Donati's Comet	1858	2,000
Great Comet of 1882	1882	760
Comet Morehouse	1908	Unknown
Comet Schwassmann-Wachmann I	1927	16.1-16.4*
Comet Humason	1961	2,900
Comet Ikeya-Seki	1965	880
Comet Tago-Sato-Kosaka	1969	420,000
Comet Bennett	1969	1,680
Comet Kohoutek	1973	75,000
Comet West	1976	500,000
Shoemaker Levy 9	1994	Unknown

*Period changes



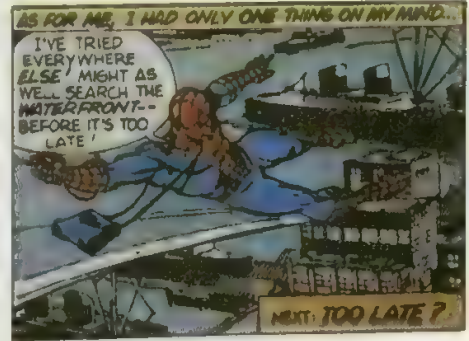
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Adventure comics, such as "Tarzan," above, tell stories of action, suspense, and violence. This example shows how the artist, Burne Hogarth, organized the text and pictures so that readers could easily follow the story. Adventure comics first became popular during the 1930's.



© 1939 King Features Syndicate, Inc.

"Krazy Kat," drawn by George Herriman from 1910 to 1944, portrayed the adventures of Krazy Kat, centre, and the mouse Ignatz.



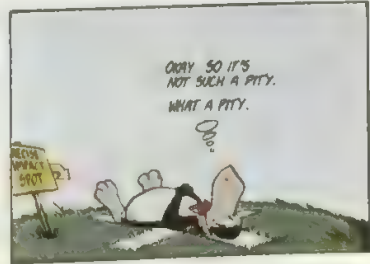
© 1966 Marvel Comics Group, Division of Cadence Industries Corp. Distributed by KFS.

Superheroes, such as Spider-Man, with their extraordinary powers, are popular in adventure comic strips.



© 1979 Field Enterprises, Inc. By permission News America Syndicate

Dramatic comics like "Rex Morgan, M.D." have ordinary people.



© 1986 Washington Post Writers Group

Satiric comics poke fun at political and social issues. In the U.S. comic strip "Bloom County," Berke Breathed created human and animal characters to express his views.

a cartoonist or illustrator draws the *panels* (individual pictures). Comic books require a great amount of material, and many artists and writers may work to produce one.

A cartoonist separates the events of a story so that they can be drawn in individual panels. The action must move smoothly from one panel to the next and, in some cases, from one instalment to the next.

The cartoonist finishes the comic strip about six weeks before it appears in print. Most cartoonists have a distributing company called a *syndicate* that acts as their business agent. The cartoonist sends the strip to the syndicate, which distributes it to newspapers in all parts of the world.

History. In the 1800's, there were few illustrations of any kind in newspapers. The first magazines published specifically for children, such as the British *Boy's Own Paper* (1879-1912), were serious, intended to instruct readers rather than entertain. The first comic strip to become widely popular, the U.S. "Hogan's Alley," appeared in 1895. Richard F. Outcault drew it for the Sunday edition of *The World* of New York City. The first successful daily comic strip, Bud Fisher's "A. Mutt" (later retitled "Mutt and Jeff"), began in 1907 in the U.S. *San Francisco Chronicle*.

With the rise of the cheap children's comic in the 1900's, the established, serious papers for young readers lost popularity. Radio and cinema were powerful in-

fluences on comics. The comic paper *Film Fun*, popular in the 1930's and 1940's, featured the comic-strip adventures of screen stars such as Laurel and Hardy.

Comics specifically for children have reflected changing tastes and interests. In the 1950's, Marcus Morris, a British publisher, launched the *Eagle* and *Girl*, which were praised for their high-quality illustration and factual accuracy. Yet while these stylish comics had declined by the 1960's, others such as the *Beano* and *Dandy*, apparently little altered by the changes in society, continued to flourish into the 1990's.

The appearance of "horror" comics alarmed some parents and teachers, who disapproved of the often violent style and subject matter. But science fiction and fantasy have continued to attract comic book readers. The detective strip, such as the U.S. "Dick Tracy" (1931), created by Chester Gould, has declined. The "superhero" adventure strip, symbolized by "Superman" (1938), created by Jerry Siegel and Joe Shuster, has continued to entertain readers worldwide.

Some newspaper strips mix entertainment with political or social comment. An example is Garry Trudeau's "Doonesbury" (1970).

The first comic book was a U.S. reprint of the adventures of "The Yellow Kid," the mischievous boy hero of the original "Hogan's Alley" comic. It appeared in 1897. In the 1920's, the first comic books made up of original material were published in Japan. Comic books began to appear in their present magazine form in the 1930's. The adventures of some newspaper picture-strip characters, such as the British favourite "Rupert Bear," have entertained several generations of children, both as newspaper strips and as "annuals" in book form.

Comics lost some popularity after television became widespread in the late 1940's. Comic books especially suffered because a few publishers printed ones that contained obscenities and violence. In 1954, almost all U.S. comic book publishers adopted the Comics Code Authority, which prohibited the publication of such material.

By the 1960's, comics had regained some of their popularity. They once appealed mostly to children and uneducated adults. But today, such strips as "Peanuts" and "Garfield" can be enjoyed by both children and adults, and by the educated as well as the uneducated. These comics are simple and funny, but they are also sophisticated.

See also Schulz, Charles Monroe; Caricature; Cartoon.

Cominform, short for Communist Information Bureau, was established in 1947. Its chief purpose was to spread propaganda. Its main publication was its newspaper, *For a Lasting Peace, for a Peoples' Democracy*. Out of the Cominform developed the Warsaw Pact. This was the Communists' answer to the North Atlantic Treaty Organization (NATO), established by non-Communist countries in 1949. The Cominform was eventually dissolved in 1956.

Comintern, short for Communist International, often called the *Third International*, was founded in 1919. V. I. Lenin, the Soviet Union's revolutionary leader, established it to organize revolutions through Communist parties in every country. Communist groups from various countries sent delegates to congresses in Moscow.

The Soviet Union dissolved the Comintern in 1943 as a friendly gesture toward the Soviet's Western allies in World War II (1939-1945). See also **Communism**; **International**, **The**.

Comitia were assemblies of the people of ancient Rome. The oldest one, the *Comitia Curiata*, confirmed the selection of kings and approved important decisions. Both the *Comitia Centuriata* and the *Comitia Tributa* elected officials, voted on issues, and made laws. The *Comitia Centuriata*, organized according to wealth, dealt with more important issues and officials. The *Comitia Tributa*, organized by tribes, became the most important lawmaking body.

Comma is a mark of punctuation shown as , . Its chief uses include (1) separating the parts of a compound sentence joined with *and*, *but*, *or*, *nor*, *for*, *so*, or *yet*; (2) setting off a phrase or clause preceding a subject—*After leaving, he felt sad*; (3) setting off a nonrestrictive modifier or a phrase in apposition—*Bob, who was next, had no trouble*; *Jim, the boss, spoke last*; (4) separating each item in a series—to *strive*, to *seek*, to *find*; and (5) separating the parts of a date, of an address, or of a name. See also **Punctuation** (The comma).

Commander in chief has supreme command of a nation's armed services. The title of *commander in chief* may also be given to an officer commanding a theatre of operations, a major naval fleet, a unified command of units from two or more of the military services, or a specified command assigned to a specific function.

Commander Islands, also called Komandorskiye Islands, are a Russian island group in the Bering Sea, east of the Kamchatka Peninsula. They cover about 1,852 square kilometres, and consist of Bering and Medny islands and two islets. The islands are mountainous, and largely covered with tundra vegetation (see **Tundra**). The people fish, and operate fox and seal fur farms. See also **Bering Sea**.

Commandments, Ten. See **Ten Commandments**.

Commando is the British term for a soldier who is trained to take part in specialized hit-and-run or raiding operations.

The word *commando* was originally a Portuguese term. It was first used in South Africa during the 1830's to describe surprise attacks by the Dutch and Portuguese settlers against the African people. Prime Minister Winston Churchill suggested the name for the British *combined operations units* that used guerrilla warfare tactics during World War II (1939-1945). Commando raids destroyed war plants and materials, rescued Allied agents, and tried out invasion tactics (see **Guerrilla warfare**).

Famous commando operations during World War II included a raid on St.-Nazaire, France, in March 1942. Commandos destroyed the largest dock in western Europe. Canadian and British commandos staged the largest raid, on Dieppe, France, on Aug. 19, 1942. They fought for nine hours, but suffered heavy losses. The United States Marine Corps employed commandos known as *Raiders* in the difficult Pacific campaign during World War II.

See also **Army**; **Rangers**; **Wingate's Raiders**.

Commedia dell'arte. See **Drama** (Italian Renaissance drama; picture).

Commensalism. See **Symbiosis**.

Commerce, Chamber of. See **Chamber of commerce.**

Commercial. See **Advertising** (Television; Radio; Creating advertisements).

Commercial art includes many types of art used for business purposes. It is often called *advertising art*, because much commercial art is used in selling products and services. Commercial art is different from *fine*, or *original art*, such as painting and sculpture, because it must be reproduced by printing or other methods.

Commercial artists work for advertising agencies, department stores, manufacturers, film studios, publishers, television stations, and many other types of businesses. They create art for such things as advertisements, books, magazines, packages, filmstrips, and trademarks. The art work in *World Book* is produced by commercial artists. Commercial art studios offer a variety of art services, and range in size from only a few to more than 100 employees. Some commercial artists work independently, and are paid according to each assignment. They are called *freelance artists*.

The early commercial artists were self-taught or had some training in fine art. These artists worked on design, drawing, lettering, and all steps in preparing a piece of art work for reproduction.

In recent years, the field has expanded and developed greatly. Today, many commercial artists specialize in such specific parts of commercial art as design, illustration, photography, and photo retouching. Specialists within these areas include fashion illustrators, product illustrators, book illustrators, technical illustrators, cartoonists, and film animators.

Some commercial artists become art directors. Art directors do little art work themselves, but they plan and direct the work of others. Many commercial artists specialize in one field of commercial art, such as the design of advertisements.

Commercial art is a relatively new profession. Few people were employed in the field before 1900, and educational training for a professional career in commercial art was not available until about 1930. Today, there are many art schools that offer training courses, and many colleges and universities offer bachelor's and master's degrees in commercial art or graphic design.

Related articles in *World Book* include:

Advertising	Engraving	Photoengraving
Cartoon	Etching	and photolithog-
Computer graphics	Graphic arts	raphy
Design	Lithography	Photography
Electrotyping		Poster

Commercial paper is a term used broadly to describe business documents that are either orders or promises to pay money. There are two main kinds of commercial paper: the *draft* and the *promissory note*. A draft is a written order to a business or individual to pay a specified amount of money to another business or individual. The most common type of draft is a cheque. A promissory note is a written promise to pay a specified sum of money to a certain person on a future date.

When financial experts speak of *commercial paper*, they use the term in a narrow sense to mean short-term promissory notes issued by companies. Many companies borrow money by selling such notes to investors. On the date specified on the note, the company pays the

investor the full amount of the note, plus interest. The interest rate on most commercial paper is less than the interest on a bank loan. Only large companies with good credit ratings can issue commercial paper. Most commercial paper *matures* (becomes due) in less than six months.

Many people believe commercial paper is a good investment, particularly during periods of inflation. The short maturity period enables investors to redeem their money quickly and reinvest it at higher interest rates. However, such notes are *unsecured*—that is, they do not give the lender legal claim to any property if the loan is not repaid.

See also **Cheque; Note.**

Commission, Military, is a written order giving an officer rank in the armed services. An officer accepts the commission voluntarily, and it does not have to be renewed. The term *in commission*, when referring to a ship or an aircraft, means that the vessel or aeroplane is ready for active service.

Committee for State Security. See **KGB.**

Committee of Public Safety. See **French Revolution** (Terror and equality).

Committee of the whole is a committee composed of all the members of an organization. Usually a large group will ask a small committee to investigate a matter and make a report to the whole group. But sometimes the whole group wants to consider the matter, and meets as a committee of the whole. The advantage of meeting in this manner, or as a committee of the whole, is that the discussion can be informal, because no official action can be taken.

After its discussion, the committee of the whole ends the meeting by *rising from the committee*. The group then returns to its regular rules and ways. The chairman or chairwoman gives an official report of any decisions to the group.

The committee of the whole is a device often used by legislative bodies. In the British House of Commons, a regular chairman or chairwoman other than the speaker is chosen to chair a committee of the whole. Any member of the United States Congress can chair a committee of the whole.

Committee on Ways and Means. See **Parliament.**

Commodity exchange is an organized market for almost any raw material or food that is produced in large quantities. Commodity exchanges are also called *boards of trade* or *commodity markets*. *Commodities* (goods) are nearly always traded without being seen, and it is unusual for the goods themselves to be physically exchanged.

The *primary goods* (raw materials) sold on commodity exchanges include beef, cattle, cocoa, coffee, cotton, grains, hides, lamb, rubber, soya oil, and sugar. Metals traded include copper, gold, lead, silver, and tin. There are important international commodity exchanges all over the world. In London, there are many important commodity exchanges, including ones for gold, fur, metals, petroleum, rubber, and tea. The Chicago Board of Trade is the largest commodity exchange in the world. In Australia and New Zealand, there are important exchanges for wool, meat, and fruit. In Malaysia, rubber and tin are traded, as is pepper in Singapore. Cotton, tea, and jute are among the commodities

that are traded in India, Sri Lanka, and Bangladesh.

There are three main types of people involved in commodity exchanges. The producer of the commodity is there to sell the goods. The user, or consumer, needs to buy the goods. The investor, or speculator, buys the commodities, but never intends to take possession of them. The investor operates in the market between the producer and the consumer, buying and selling to make a profit.

There are two main methods of selling on commodity exchanges. These are known as the *spot market* and the *futures market*.

Spot market deals in commodities that are available for immediate delivery. The spot price is the current cash value of the commodity being sold. The spot market is also called the *noncontract market*.

Futures market, sometimes called the *contract market*, is where most commodity business is transacted. The buyer *contracts* (agrees) to buy a certain quantity of a commodity at an agreed price for delivery at a specified later date—for example, six months later. If the buyer is the user or consumer, this method of purchase gives him the security of knowing that if the spot price of the goods fluctuates after he has made his contract, he cannot lose money because he has bought at a fixed price. The producer selling "forward" also benefits if the price falls in the meantime. When buyers and sellers act to reduce the risk of losing money because of changing prices, they are said to be *hedging*. The other broad category of future trading is *speculative trading*.

Speculative trading is buying or selling futures contracts in hopes of making a profit from future price changes (see *Bears and bulls*).

A major difference between commodities and manufactured goods is that commodities can undergo sharp fluctuations in price. Good weather may produce a bumper rice crop, and as a result there will be more rice than people want to buy. So the price will go down to help increase the demand. But if supplies are short, because rice harvests have been spoilt by flooding, for instance, the price will rise sharply. If fewer people are buying motor cars, the price of rubber may go down. In general, developing countries are most affected by movements in the price of commodities. They are the main producers of commodities, and their livelihood often depends on income from exports of just one or two commodities.

International commodity agreements between users and producers have been arranged to try to re-

duce the sharp rises and falls in commodity prices. In 1977, the United Nations recommended that 18 commodities be brought under such agreements. Agreements on commodities usually set two prices: a *floor* (lowest) price and a *ceiling* (highest) price. If the price of a commodity falls below the floor price, a central organization buys enough of the commodity to bring the price up to the required level. When the price rises above its ceiling, the commodity is released from stock onto the market to force the price down. Such agreements have not been very successful, however. In some cases, a major producer or user refuses to be included in the agreement. In other cases, either the producers or the consumers refuse to honour the agreement.

Another method of trying to stop extreme price movements in commodities is by setting *quotas* (limits) on the production or export of commodities. If one producer refuses to keep to the agreed amount, however, the system breaks down.

Common Bible. See *Bible* (Modern English translations).

Common carrier is a person or company who exercises the profession of carrying goods or passengers for a reasonable price, and is available to anyone who wishes to use him. A common carrier is liable for the safety of goods entrusted with him in all events except those caused by (1) acts of God or enemies of the government; (2) the fault of the *consignor* (the person who hands over the goods to the carrier); or (3) an inherent vice in the goods themselves.

See also *Contract*; *Common law*.

Common law is a body of rulings made by judges on the basis of community customs and previous court decisions. It forms an essential part of the legal system of many English-speaking countries, including Australia, Canada, England, New Zealand, and the United States. Common law covers such matters as contracts, ownership of property, and the payment of claims for personal injury.

Common law is often contrasted with *civil law*, a body of rules passed by a legislature. Under civil law, a judge decides a case by following written rules, rather than previous court decisions.

Common law differs from *equity*, a set of standards developed to allow greater flexibility in court decisions. During the late Middle Ages, England created courts of equity to decide cases that courts of common law might treat too strictly. The monarch's chancellor presided over a court of equity called the *court of chancery*.



The Chicago Board of Trade is the world's largest commodity exchange. On its busy trading floor, brokers buy and sell contracts for immediate and future deliveries of maize, wheat, and other products.

Courts of equity decided cases by broad principles of justice and reason, rather than by common law.

Countries that use the common law system have developed the basic rules of law in their own way, depending on the needs and customs of their societies. In modern times the legal systems of developed countries rely heavily on *statute law* (legislative acts) in business and commerce, as well as for the protection of human rights and freedoms. But every law that is passed is open to interpretation by the courts and so common law continues to be generated.

See also **Civil Law**; **Equity**; **Law**; **Lien**.

Common market is an economic union of nations. Members of a common market work to eliminate tariffs and other trade barriers among themselves and to follow a uniform trade policy with nonmember countries. The members also work to achieve free movement of workers and financial capital from one member nation to another. Nations form common markets to stimulate industrial growth and efficiency, to increase employment, and to make more and cheaper goods and services available to consumers. The European Union is a common market. For more information on how a common market operates, see **European Union**.

The Council for Mutual Economic Assistance (Comecon) was an association of nations linked to the former Soviet Union. Bulgaria, Czechoslovakia, Hungary, Poland, Romania, and the Soviet Union founded Comecon in 1949 to coordinate the development of their economies. The Soviet Union broke up into a number of independent countries in 1991. In the same year, 11 former Soviet republics formed the Commonwealth of Independent States (C.I.S.). In 1993, the C.I.S. replaced Comecon with the C.I.S. Economic Union, a common market similar to the European Union. See **Commonwealth of Independent States**.

Some groups of countries have partially or completely removed trade barriers among themselves. However, they are not true common markets because each member maintains its own trade policies with nonmember countries, and workers and capital do not move freely among the members. These groups—or the agreements that have established them—include:

Arab Common Market. Founded: 1964. Members: Egypt, Iraq, Jordan, Libya, Mauritania, Syria, and Yemen.

Association of Southeast Asian Nations (ASEAN). Founded: 1967. Members: Brunei, Indonesia, Malaysia, Philippines, Singapore, and Thailand. See **Association of Southeast Asian Nations**.

Australia-New Zealand Closer Economic Relations Trade Agreement. Went into effect: 1983. Parties: Australia and New Zealand.

Caribbean Community and Common Market (CARICOM). Founded in 1973 to replace the Caribbean Free Trade Association (CARIFTA), which was established in 1965. Members: Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Montserrat, Saint Christopher and Nevis, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago.

European Economic Area (EEA). Founded: 1994. Members: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Liechtenstein, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, and the United Kingdom.

European Free Trade Association (EFTA). Founded 1960. Members: Iceland, Norway, and Switzerland. See **European Free Trade Association**.

North American Free Trade Agreement (NAFTA). Went into effect: 1994. Parties: Canada, Mexico, and the United States.

Common Sense. See **Paine, Thomas**.

Commons are tracts of open land that people may use in common. Today, most people use commons for recreation. But during the Middle Ages, in England, people used commons for grazing their animals, cutting wood, and digging turfs (peat). These activities are called *rights of common*. The lord of a manor granted his tenants these rights on his land, because the tenants' own land was sufficient only for growing crops. In 1967, registration of all common land and of town and village greens began.

Commons, House of. See **House of Commons**.

Commonwealth is a term sometimes used for a state, a country, or a group of states and countries. The term has no precise definition in international law. Any group of nations may sign a treaty pledging political or economic support to one another and call themselves a commonwealth. The term originally meant a group of people banded together for the common good or public welfare.

Australia is made up of several states. Its official name is The Commonwealth of Australia. The Commonwealth of Nations includes such countries as the United Kingdom, Canada, Australia, and New Zealand (see **Commonwealth of Nations**). The United States may be called a commonwealth. The U.S. states of Pennsylvania, Massachusetts, Virginia, and Kentucky call themselves commonwealths.

Commonwealth Day is celebrated in the United Kingdom (UK) on the second Monday in March. Similar celebrations are held in other Commonwealth countries at various times of the year. Commonwealth Day, originally called Empire Day, was first celebrated in 1902, on May 24, Queen Victoria's birthday. The present date was fixed in 1977.

Commonwealth Games is the name given to a sporting competition open to individuals and teams representing countries from within the Commonwealth of Nations (see **Commonwealth of Nations**). The games are staged every four years, about halfway through the period between successive Olympic Games meetings. Each meeting is in a different Commonwealth country. The games were held in Canada in 1930, 1954, 1978, and 1994; in Australia in 1938, 1962, and 1982; in New Zealand in 1950, 1974, and 1990; in Scotland in 1970 and 1986. England held the games in 1934; Wales in 1938; and Jamaica in 1966. Contestants at the Commonwealth Games compete in any of 10 sports. There are athletics and swimming competitions in every meeting, but the other 8 sports vary. Sports that have featured in past meetings include archery, badminton, bowls, boxing, cycling, fencing, gymnastics, judo, rowing, shooting, weightlifting, and wrestling. The controlling body of the Commonwealth Games is the Commonwealth Games Federation.

Although the United Kingdom is one member of the Commonwealth, the four countries of England, Scotland, Wales, and Northern Ireland compete separately



The Commonwealth Games take place every four years. Competitors from different nations add to the colourful spectacle as they celebrate the closing ceremony at the 1990 Games, held in Auckland, New Zealand

in the Commonwealth Games. The Isle of Man, Jersey, and Guernsey each send a team to the games.

As in the Olympic Games, the winning individual or team in an event in the Commonwealth Games receives a gold medal. The person or team placed second wins a silver medal, and the third-place competitor or team is awarded a bronze medal.

Two individual competitors have won a record 9 gold medals. They are fencer Bill Hoskyns of England (during the period 1958-1970) and Australian swimmer Michael Wenden (during 1966-1974). The largest number of golds won by a woman is 7, awarded to Australian sprinters Marjorie Jackson (at the meetings of 1950 and 1954) and Raelene Boyle (between 1970 and 1982). The Australian shooter Phillip Adams holds the record for the greatest number of medals won by any male competitor, with a total of 14 (6 gold, 7 silver, and 1 bronze) gained during the three meetings from 1982 to 1990. The greatest number of medals won by a woman is 9 (7 gold and 2 silver), gained by Raelene Boyle between 1970 and 1982. Canadian swimmer Graham Smith won a record 6 golds in one meeting in 1978. Two Australian women have each won 5 gold medals in one meeting—Decima Norman (1938) and Hayley Lewis (1990).

History. The Commonwealth Games developed from the earlier Empire Games. An Englishman, J. Astley Cooper, suggested the holding of an Empire Games competition in a magazine article in 1891. The idea was revived after the 1908 Olympic Games by Australian sportsman Richard Coombes, and in 1911 an inter-Empire sports competition was held in London as part of the celebrations of the coronation of King George V of Britain.

The first official Empire Games took place at Hamilton, Ontario, in Canada in 1930. In 1954, the contest was renamed the British Empire and Commonwealth Games and was held under that title at Vancouver, Canada. In 1970, the word "Empire" was dropped from the title of the games. Eight years later the word "British" was dropped, too, and the first *Commonwealth Games* were held at Edmonton, Alberta, in Canada.

The Commonwealth Games, like the Olympic Games have suffered from the effects of world politics. African Commonwealth countries have *boycotted* (stayed away from) the games on several occasions in protest against other nations having sporting links with South Africa. Like many other countries, African members of the Commonwealth refused to have dealings with South Africa during the years that *apartheid* (official racial segregation) was a policy of the South African government. In 1994, South Africa returned to the Commonwealth Games, held at Victoria, British Columbia, Canada, after an absence of more than 30 years.

Commonwealth Institute is a building in London that houses exhibitions about the Commonwealth of Nations and its members. The institute's exhibitions illustrate the scenery, way of life, and industries of Commonwealth countries. The exhibitions also include examples of Commonwealth products and handicrafts. The institute also has an art gallery, a library, a restaurant, and a cinema. Admission is free of charge.

Commonwealth of England. See *Civil War, English* (The Commonwealth); *England* (History [The Civil War]); *United Kingdom, History of the* (The Commonwealth).

Commonwealth of Independent States is a loose association of independent nations that were formerly republics of the Soviet Union. These member nations are Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan. The headquarters of the commonwealth is Minsk, in Belarus.

The Soviet Union was made up of 15 republics. In 1990, several republics declared their independence. In August 1991, the Soviet Union began to break apart after an attempted coup. All the other republics except Russia declared their independence during the coup or soon after. Russia proclaimed itself the successor to the Soviet Union. Eleven republics formed the Commonwealth of Independent States (C.I.S.) in December 1991, shortly before the Soviet Union ceased to exist. Georgia joined

The Commonwealth Institute, in London, is an international social and cultural centre. Its exhibitions attract many visitors of all ages



the C.I.S. In 1993. The former republics that did not join the C.I.S. are Estonia, Latvia, and Lithuania.

The C.I.S. was created for several reasons. Many of the members wanted to keep some of the economic ties they had with one another as Soviet republics. Each of the members also wanted to guarantee its own territory and sovereignty. The C.I.S. members also sought to reassure the rest of the world that the nuclear weapons of the former Soviet Union were under reliable control (see Disarmament).

Despite the goals of the C.I.S., members soon began to dispute various matters. The C.I.S. originally aimed to have a single military for all its members, but later abandoned that plan. Most of the member countries have announced their intention of creating their own armed forces. Russia and Ukraine have disputed the ownership of the Crimea, a strategically important peninsula in the Black Sea. Many of the C.I.S. countries rejected the idea of continuing to use the rouble—the former Soviet monetary unit—as their own official currency. Some C.I.S. countries have created their own currencies.

Experts believe many of the commonwealth's problems result from a lack of clear purpose or structure. Russia saw the C.I.S. as permanent. But other members expressed fears that Russia—with its great size and power—might dominate the C.I.S. Some of the members, such as Ukraine, viewed the C.I.S. as just a temporary association to help the former republics become truly independent countries. The C.I.S. does not have a charter that sets forth its duties and powers, and lacks a governing body to enforce decisions or settle conflicts.

C.I.S. members moved toward closer economic integration in 1993. In July 1993, Belarus, Ukraine, and Russia agreed to form a customs union and a single market.

Commonwealth of Nations is an association of independent countries and other political units that have lived under British law and government. The association includes the United Kingdom (UK) itself and 50 other independent nations that were once UK colonies. It also includes about 25 other political units, such as territories and dependencies.

Commonwealth members cover about a quarter of the earth's land surface and have about a quarter of the world's population. Commonwealth nations range in size and wealth. Some nations, such as Australia and Canada, are rich industrial nations. Their peoples enjoy a high standard of living. India and Pakistan in Asia and Kenya and Nigeria in Africa, are examples of Commonwealth countries that are developing their industries and agriculture, and building modern economies. Bangladesh, another Commonwealth nation, is a poor nation, with a low average income per head.

India, with a population of more than 850 million people, has more inhabitants than any other Commonwealth nation. The Commonwealth nation with the largest land area is Canada. Within the Commonwealth there are small independent nations such as St. Christopher and Nevis, with fewer than 50,000 people. Two of the smallest countries in the world, the Pacific islands of Nauru and Tuvalu, have special membership status within the Commonwealth of Nations.

The UK is involved in some way in the government

Members of the Commonwealth of Independent States

Name	Area in km ²	Population	Capital	Official language
Armenia	29,800	3,373,000	Yerevan	Armenian
Azerbaijan	86,600	7,447,000	Baku	Azerbaijani
Belarus	207,600	10,480,000	Minsk	Belarusian
Georgia	69,700	5,473,000	Tbilisi	Georgian
Kazakhstan	2,717,300	16,992,000	Almaty	Kazakh
Kyrgyzstan	198,500	4,409,000	Bishkek	Kyrgyz
Moldova	33,700	4,350,000	Chisinau	Romanian
Russia	17,075,400	151,436,000	Moscow	Russian
Tajikistan	143,100	5,252,000	Dushanbe	Tajik
Turkmenistan	488,100	3,631,000	Ashgabat	Turkmen
Ukraine	603,700	53,125,000	Kiev	Ukrainian
Uzbekistan	447,400	20,453,000	Tashkent	Uzbek

of a number of the units in the Commonwealth. In some others, Australia or New Zealand has some involvement in the government.

The Commonwealth countries have a tradition of mutual cooperation that stems from their common history. The Commonwealth of Nations conducts various programmes through Commonwealth agencies. For example, several jointly financed programmes provide economic aid and technical assistance to developing nations in the group. The Commonwealth also supports agencies that promote cooperation in such activities as broadcasting, cable and satellite communication, education, health care, and scientific research. The Commonwealth Secretariat leads and coordinates Commonwealth activities.

The Commonwealth heads of government assemble from time to time to exchange views on important international issues. At these meetings, the leaders seek to identify common goals in economic and foreign affairs. They work to coordinate their national policies to pursue these goals. But the nations are not required to obey conclusions reached at the conferences.

Independent members of the Commonwealth of Nations are former British colonial areas, dependencies, or dominions, once governed by the UK, that have become self-governing but have retained their Commonwealth ties. Despite the Commonwealth's tradition of cooperation, each nation has its own foreign policy, which reflects its own particular interests.

All the independent members recognize the monarch of the United Kingdom as head of the Commonwealth. But the monarch is mainly a symbol and has no real power to govern. The UK and about 15 other Commonwealth nations are monarchies that regard the UK ruler as head of state. A few others have their own monarchs. More than half the Commonwealth nations are republics.

Dependencies are Commonwealth areas that do not have complete self-government. They are administered by independent Commonwealth members. Some dependencies are developing toward self-government, al-

though other dependencies are too small or too thinly populated to take this step in the foreseeable future.

A majority of the dependencies are areas that have been annexed to the *British Crown* (the UK). This means that people living in them are UK citizens. These dependencies were formerly called *colonies* or *crown colonies*. A governor appointed by the UK government is the highest official in each such dependency. The governor holds all political power in some dependencies. Others have elected assemblies, and in them the governor's power is limited. Some of the dependencies have become practically self-governing. Most of these areas are ruled as though they were parts of the UK.

The term *dependency* may also refer to other kinds of political units. These political units include *crown dependencies*, *joint administrations*, *self-governing areas*, and *territories*.

Crown dependencies are self-governing territories annexed to the British Crown. They are not bound by acts of the UK Parliament unless the crown dependencies are named.

Joint administrations are controlled by two nations that have interests there. Each nation has responsibility for its own property and personnel in the area.

Self-governing areas control their own internal affairs. They have agreed to let a Commonwealth nation handle their defence and foreign relations. However, self-governing areas have the right to declare full independence at any time.

Territories are dependencies of Australia or New Zealand. Each territory has an administrator chosen by the government of Australia or New Zealand. In some territories, this official holds all political power. In other territories, the administrator shares power with an elected assembly. Some territories have become nearly self-governing. Australia and New Zealand control defence and foreign policy for their territories.

Commonwealth consultation. The Commonwealth is often spoken of as a kind of club. Members agree to share ideas and discuss world issues without being committed to any action as a result. The Commonwealth



Secretariat was set up in 1965. It is financed by the member nations and is headed by a secretary-general. The secretariat has its headquarters in London. It organizes meetings and conferences, distributes information, and helps coordinate Commonwealth activities. The secretariat also administers the Commonwealth Fund for Technical Cooperation. In the case of a dispute between members, the secretariat is regarded as being neutral and may be asked to help the disputing parties settle their disagreement.

The Commonwealth Fund for Technical Cooperation exists to give technical aid for economic and social development in developing nations of the Commonwealth. It helps poorer Commonwealth nations to develop their exports and increase their food production.

The Commonwealth Scholarship and Fellowship Plan is an educational scheme to help Commonwealth students study in countries other than their own.

The Commonwealth Foundation promotes cooperation between professional and other nongovernmental organizations within the Commonwealth.

Two London-based institutions that promote the Commonwealth through exhibitions, educational programmes, and scholarship are the Commonwealth Institute and the Royal Commonwealth Society. The Society has branches in many Commonwealth countries.

There are other Commonwealth organizations which link professional people such as architects, doctors, engineers, and librarians. Parliamentarians meet at the annual conference of the Commonwealth Parliamentary Association.

Commonwealth conferences are held at two-year intervals. Heads of government and senior ministers meet to discuss matters of common concern. Recent conferences have been held at Nassau, Bahamas, in 1985, at Vancouver, Canada, in 1987; at Kuala Lumpur, Malaysia,

The Commonwealth of Nations

Members	Location	Status	Members	Location	Status
Independent members			Uganda	Africa	Republic
Antigua and Barbuda	Caribbean Sea	Monarchy	United Kingdom	Europe	Monarchy
Australia	Pacific Ocean	Monarchy	Vanuatu	Pacific Ocean	Republic
Bahamas	Atlantic Ocean	Monarchy	Western Samoa	Pacific Ocean	Republic
Bangladesh	Asia	Republic	Zambia	Africa	Republic
Barbados	Caribbean Sea	Monarchy	Zimbabwe	Africa	Republic
Belize	Central America	Monarchy	Dependencies of the United Kingdom		
Botswana	Africa	Republic	Anguilla	Caribbean Sea	Dependency
Brunei	Asia	Monarchy	Bermuda	Atlantic Ocean	Dependency
Canada	North America	Monarchy	British Antarctic Territory	Antarctica	Dependency
Cyprus	Mediterranean Sea	Republic	British Indian Ocean Territory	Indian Ocean	Dependency
Dominica	Caribbean Sea	Republic	British Virgin Is.	Caribbean Sea	Dependency
Gambia	Africa	Republic	Cayman Islands	English Channel	Crown dependencies
Ghana	Africa	Republic	Falkland Islands	Atlantic Ocean	Dependency
Grenada	Caribbean Sea	Monarchy	Gibraltar	Europe	Dependency
Guyana	South America	Republic	Hong Kong	Asia	Dependency
India	Asia	Republic	Man, Isle of	Irish Sea	Crown dependency
Jamaica	Caribbean Sea	Monarchy	Montserrat	Caribbean Sea	Dependency
Kenya	Africa	Republic	Pitcairn Islands	Pacific Ocean	Dependency
Kiribati	Pacific Ocean	Republic	Group	Atlantic Ocean	Dependency
Lesotho	Africa	Monarchy	Saint Helena	Atlantic Ocean	Dependency
Malawi	Africa	Republic	Turks and Caicos Islands	Caribbean Sea	Dependency
Malaysia	Asia	Monarchy	Territories of Australia		
Maldives	Indian Ocean	Republic	Antarctica (Aust.)	Antarctica	Territory
Malta	Mediterranean Sea	Republic	Ashmore and Cartier Islands	Timor Sea	Territory
Mauritius	Indian Ocean	Republic	Christmas Island	Indian Ocean	Territory
Namibia	Africa	Republic	Cocos (Keeling) Is.	Indian Ocean	Territory
Nauru	Pacific Ocean	Republic	Coral Sea Islands	Pacific Ocean	Territory
New Zealand	Pacific Ocean	Monarchy	Heard Island and McDonald Islands	Indian Ocean	Territory
Nigeria	Africa	Republic	Norfolk Island	Pacific Ocean	Territory
Pakistan	Asia	Republic	Areas associated with New Zealand		
Papua New Guinea	Pacific Ocean	Monarchy	Cook Islands	Pacific Ocean	Self-governing area
St. Christopher and Nevis	Caribbean Sea	Monarchy	Niue Island	Pacific Ocean	Self-governing area
St. Lucia	Caribbean Sea	Monarchy	Ross Dependency	Antarctica	Territory
St. Vincent and the Grenadines	Caribbean Sea	Monarchy	Tokelau	Pacific Ocean	Territory
Seychelles	Indian Ocean	Republic			
Sierra Leone	Africa	Republic			
Singapore	Asia	Republic			
Solomon Islands	Pacific Ocean	Monarchy			
South Africa	Africa	Republic			
Sri Lanka	Indian Ocean	Republic			
Swaziland	Africa	Monarchy			
Tanzania	Africa	Republic			
Tonga	Pacific Ocean	Monarchy			
Trinidad and Tobago	Caribbean Sea	Republic			
Tuvalu	Pacific Ocean	Monarchy			

in 1989; at Harare, Zimbabwe, in 1991, and at Cyprus, in 1993. In the early 1990's, a key issue was the Commonwealth policy toward South Africa. South Africa left the Commonwealth in 1961 when other members opposed its policy of *apartheid*, or separation of the races. South Africa rejoined in 1994, when Nelson Mandela became president in the country's first nonracial elections.

Pakistan left the Commonwealth in 1972, when the existence of Bangladesh (formerly part of Pakistan) was officially recognized by Commonwealth members. Bangladesh became a full member and, after a 17-year absence, Pakistan rejoined the Commonwealth of Nations in 1989.

Normal day-to-day diplomatic contacts between Commonwealth nations are done through offices called high commissions. High commissioners are the Commonwealth equivalent of ambassadors.

History. The Commonwealth of Nations began to take form in the early 1900's. At that time, representatives of certain UK colonies met with UK representatives at Imperial Conferences. All these colonies had self-government in domestic affairs. But the UK managed their foreign policy and defence.

During the 1910's and 1920's, the self-governing colonies moved toward independence in foreign affairs. Representatives at a 1926 Imperial Conference declared all participating countries to be completely self-governing nations. They described these nations as equal in rank, "united by a common allegiance to the Crown and freely associated as members of the British Commonwealth of Nations." The Statute of Westminster, a UK law of 1931, legalized the 1926 declaration. The original Commonwealth members were Australia, Canada, Ireland, New Zealand, Newfoundland, South Africa, and the United Kingdom.

In 1932, the Commonwealth nations established a system of trade called *Commonwealth Preference*. Under this system, the UK imported goods from other Commonwealth countries without imposing the usual tariffs. Other Commonwealth nations negotiated favourable trade agreements with each other.

Between 1947 and 1980, about 40 more UK colonies became independent nations. Nearly all joined the Commonwealth. During the same period, Newfoundland became a province of Canada, and Ireland and South Africa gave up Commonwealth membership because of disagreements with other countries in the group. By the mid-1960's, nearly half the Commonwealth members were African nations. Another newly-independent nation, Namibia, joined the Commonwealth in 1990 after gaining independence from South Africa.

In 1977, the UK completed a plan to discontinue its special trade agreements with Commonwealth nations. It began this plan in 1973, when it joined the European Community (now known as the European Union).

The Commonwealth is changing as member nations develop, and also strengthen their relationships with neighbour states in their own regions. The UK is no longer regarded automatically as the leader of the Commonwealth. The UK's membership of the European Union since 1973 has meant that it no longer looks first to the Commonwealth for trading partners. Canada has become more closely linked, financially and economically, with the United States. Australia and New Zealand

have developed active policies in the Pacific and South-east Asian regions. Brunel, Malaysia, and Singapore are members of the Association of Southeast Asian Nations. African Commonwealth nations are strengthening their links with other African states. Caribbean Commonwealth nations have trade and other links with neighbouring states in the region.

Yet despite these evolving relationships, the Commonwealth remains an active organization. An important common bond is the English language, used widely throughout the Commonwealth. Educational, legal, and commercial systems in Commonwealth nations are also in many cases similar.

Related articles. All of the countries and most of the other political units in the table with this article have separate articles in *World Book*. Other related articles include:

British America	Flag (pictures)
Colony	Governor general
Commonwealth Games	Protectorate
Commonwealth Institute	Territory

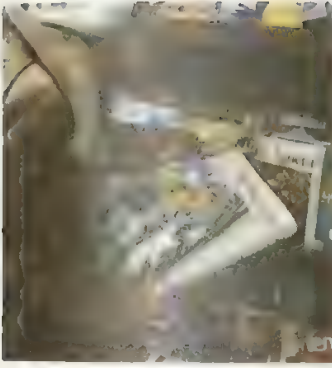
Communal society is a community formed by people who believe that they can make a better life together than any of them could make alone. Members of communal societies value *collective* (group) needs above personal needs. Most of these societies are based on a shared interest, such as religion or politics. For example, members of a religious group called *Hutterites* have established communal societies that follow the laws of the Bible (see *Hutterites*). Some communal societies, such as the *kibbutzim* in Israel, are cooperative farming settlements (see *Kibbutz*). A communal society created as an example of a better world is called a *utopia*.

Communal societies differ from traditional society mainly in the ways they favour collective needs. No one owns private land in most communal societies. Some communal societies may also forbid marriage or single-family households. In nearly all successful communal societies, members do all their work for the community and restrict contact with the rest of society.

In the 1800's, such European thinkers as the Comte de Saint-Simon, Robert Owen, Etienne Cabet, and Pierre-Joseph Proudhon reacted against the uneven distribution of wealth in society. They sought a cure for the evils in society through a communal society that would allow some private ownership, but not inherited wealth. These ideals inspired communal societies in many countries, including France, Japan, Tanzania, the United Kingdom and the United States.

A strong interest in communal living also developed in some countries, notably the United States, in the 1960's and the 1970's. During this period, young people formed thousands of cooperative groups called *communes* in all parts of the country. Most of these communes had disbanded by the early 1980's.

See also *Amanites*; *Brook Farm*; *Shakers*.
Commune is the smallest district of local government in France and some other countries. The French commune has a mayor (*maire*) who governs the town with the help of deputies and a council. A commune may be a small village or a large city. Usually 12 communes make up a *canton*, the next largest political division.
See also Austria: Government.; **Communal society**.
Communicable disease. See **Disease** (infectious diseases; table).



Newspapers and magazines



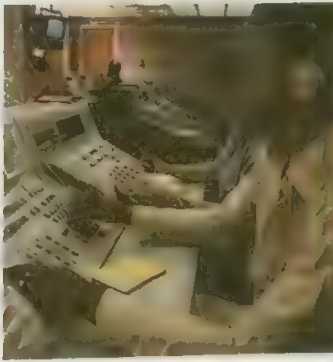
Citizens band (CB) radio



Radio broadcast



Letters



Operator-assisted telephone calls



Classroom discussion

The many kinds of communication enable people to share information and provide entertainment in a variety of ways. The pictures on this page show some examples of how people communicate with other individuals, with small groups, and with a large audience.

Communication

Communication is sharing information or providing entertainment by speaking, writing, or other methods. Probably the most important type of communication is personal communication, which happens when people make their thoughts and wishes known to one another. People communicate in many ways, including by talking, by moving their hands, and even by making faces. People also use telephone calls and letters for personal communication. Without personal communication, parents would not know what their children need. Teachers could not help their students learn. Friends could not make plans with one another. People could not share knowledge. Each person would have to learn everything for himself or herself. In fact, human beings probably could not survive for long.

Another important type of communication happens when messages are sent to a large audience. That type of communication is called *mass communication*. Books are one of the oldest methods of mass communication. Television is one of the newest. Newspapers and radio are other ways that information can be sent to many people. Just as human beings probably could not survive without personal communication, modern coun-

tries probably could not exist without mass communication. News of election results, earthquakes, or other important events can spread to huge numbers of people in minutes through mass communication.

This article deals with human communication. For information on animal communication, see *Animal (Bodies [Communication])*.

The Importance of communication

Communication is all around us. Most large cities have at least one daily newspaper. We often see the letter carriers that deliver mail. The air around us contains invisible television signals that can be picked up and changed into sounds and pictures by a TV set. We use communication in many ways at home, at school, in business and industry, and in world affairs.

At home, we use many types of personal and mass communication. A clock radio may wake us up in the morning, tell us the time and what weather to expect, and report the day's news. A telephone allows us to talk privately to persons nearby or far away. A note from someone in the family may say that a friend has called or remind us of an appointment.

A newspaper provides many kinds of communication. Some articles, such as news stories and recipes, furnish information. Other features, such as comic strips and humorous articles, are mostly for fun.

Many millions of people watch television for amusement during their free time. But television provides viewers with more than just entertainment. Most people get a large proportion of their news from TV news broadcasts. TV commercials also provide information on products and services.

At school, teachers use a variety of communication methods to help their students learn. Often, they lecture to an entire class or guide a group discussion. At other times, teachers help students individually.

Textbooks are probably the type of mass communication used most often in school. Teachers also use many other communication devices, including slides, posters, sound and video recordings, and films. Educational films give students many experiences they could never have in real life. Actors and actresses re-create important events in history, such as the French Revolution or Christopher Columbus' landing in America. Films take students to distant worlds, such as the bottom of the ocean or the South Pole. Animated cartoons show processes that students could not otherwise see, such as the working of a car engine or how the human body fights germs.

Many classrooms have TV sets that receive specially prepared lessons by way of *closed-circuit television*. Such television is sent by wires to a limited number of viewers and not broadcast over the air. Teachers also encourage their students to watch TV broadcasts of important events, such as the launching of a spacecraft or a message from the head of government.

In business and industry. Nearly every large business has workers throughout the country, such as employees at branch offices and salespeople calling on customers. For this reason, businesses need fast, de-

pendable communication. Much business communication takes place by telephone or by devices called *teleprinters* and *facsimile machines*, which send and receive written messages over wires. Using such communication, a chain of stores can change the price of an item in all its stores in a few minutes. Before the days of speedy communication, it would have taken weeks to inform every store.

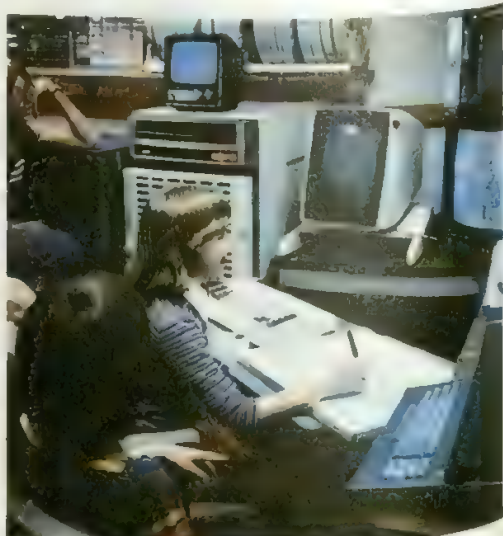
Many businesses have a communication network consisting of two or more computers linked by private telephone lines. The computers exchange vast quantities of data at high speed. The machines then translate the information into written form by means of high-speed printers, or screens called *visual display terminals* (VDTs) containing *cathode-ray tubes* (CRTs).

Most large corporations also print their own magazines or newspapers for their employees. These publications are called *house organs*. They provide information about the company's plans, new products, and other matters. A large business may also communicate with its employees by closed-circuit television and may produce its own training films and videotape recordings.

In world affairs. In the days before modern fast communication, news travelled slowly between nations. The long time needed to receive messages sometimes caused problems. For example, the War of 1812 (between Britain and the United States) might never have happened if there had been telegraphs or telephones then. The war began partly because Great Britain interfered with U.S. shipping. The United States declared war on Britain on June 18, 1812. Two days before the declaration, Britain had announced it would stop interfering with U.S. shipping. But the news had to cross the Atlantic Ocean by ship and did not reach the United States until the fighting had begun. Faster communication also would have prevented the chief battle of the war. Soldiers fought the battle at New Orleans in January 1815, 15 days after a peace treaty had been signed in Europe.



At home, family members communicate by talking, by gesturing, and by other means. Such personal communication enables parents to help their children learn and solve problems.



At school, students use many communication devices, such as this computer. When a student moves the computer's drawing tool, centre, lines and colours appear on the screen.

About 315 people were killed and about 1,290 were wounded in that battle.

Even speedy communication can bring bad results if messages are not carefully expressed. In 1945, near the end of World War II, the United States and its allies sent radio messages to Japan warning that the Japanese faced "prompt and utter destruction" if they did not surrender. Japanese officials intended to answer that they would withhold comment until they had more time to think about the message. Instead, they replied with a word that meant they would ignore the warning. If a different reply had been chosen, the United States might not have dropped atomic bombs on the Japanese cities of Hiroshima and Nagasaki. About 132,000 men, women, and children were dead or missing after the blasts, which some people believe happened partly because of this failure of communication.

People often say that communication has made the world grow smaller. The world seemed huge when messages from Europe reached North America only after an ocean voyage of many weeks. Now, radio can transmit a human voice around the world in a fraction of a second. Almost as quickly, a person can telephone another person in nearly any country. Communications satellites have made worldwide TV broadcasting possible. Viewers at home can watch events on another continent, such as a Nobel Prize ceremony or the signing of a treaty.

The development of communication

Prehistoric times. Early people probably communicated with one another by sounds and gestures long before they developed actual words. No one knows how human speech began, but experts who study language and prehistoric ways of life have made a number of guesses. Many of these scholars think language began as an imitation of sounds in nature, such as the barking of certain animals and the howling of wind.

After language developed, people exchanged news chiefly by word of mouth. Runners carried spoken messages over long distances. People also used drumbeats, fires, and smoke signals to communicate with other people who understood the codes they used.

Paintings and drawings were the first steps toward a written language. Prehistoric artists began to use a series of pictures to tell a story, such as the history of a good hunting trip or a violent storm. Gradually, people developed a system of small pictures that stood for most common objects and ideas. Such a system is known as *pictographic writing*. Middle Eastern people called Sumerians developed the first pictographic writing about 3500 B.C.

Pictographic writing worked well for familiar things but people had difficulty writing new or unusual words. Gradually, they learned to make each symbol represent a sound instead of an object or idea. As a result, they could write any word in the spoken language.

Writing ranked second only to speech among the most important early inventions in communication. It enabled people to exchange messages over long distances without depending on a messenger's memory. Information also could be kept for later use. With the invention of writing, prehistoric times ended and the period of written history began.

During ancient times, the chief means of long-distance communication was writing. Businesses and wealthy individuals hired professional messengers, who carried letters on foot, on horseback, or by ship. Military leaders also used homing pigeons to carry messages.

About 500 B.C., the ancient Greeks developed a fast method of sending messages from city to city. The system was based on a series of brick walls. The walls were close enough together so that each could be seen from the one next to it. Indentations along the top of each wall represented the letters of the alphabet. To send a message, a person lit fires in the appropriate places on



Business and Industry need fast, dependable communication. This company uses printed materials, telephones, and a computer system with video terminals and an electronic board.



In world affairs, important events are reported by newspapers, magazines, radio, and television. These reporters are attending a press conference with political leaders.

the wall. A watcher on the next wall saw the fires and relayed the message. This system of communication is called a *visual telegraph*.

The ancient Romans got news from a handwritten sheet called *Acta Diurna* (Daily Events). A few copies of the paper were made each day and posted in public.

During the Middle Ages, which began about A.D. 400 and lasted about a thousand years, Christianity had an important influence on communication. Few people could read and write, and most of those who could were church leaders. As a result, most books and other written communication involved religious themes.

Artists called *scribes*, most of whom were monks, copied books by hand, letter by letter. No two books were exactly alike. The scribes decorated their work with pictures and designs in gold, silver, and colours.

Because scribes often toiled for months to produce a single volume, the number of books they produced was small. But the output was sufficient for the small number of people who could read. Many scribes themselves could not even read the books they copied.

Most news during the Middle Ages spread by word of mouth. Town criers walked the streets announcing births, deaths, and other events of public interest. Entertainers, peddlers, and other people who travelled from place to place also carried messages and news.

The start of printing in the Western world came during the Renaissance, a period of great intellectual activity that spread throughout Europe from the 1300's to

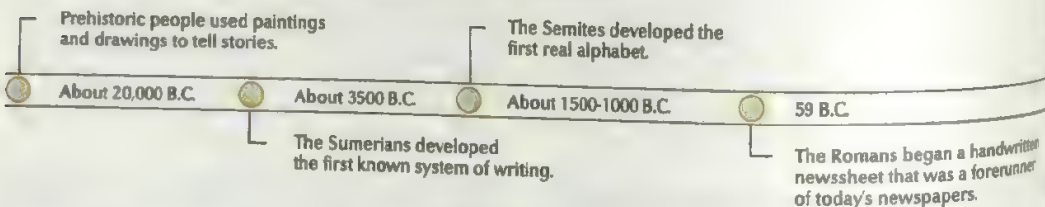
the 1600's. The intellectual awakening of the Renaissance created a demand for books that hand copying could not satisfy. The problem was solved by the invention of printing, which had been known for centuries in Asia but was not discovered in Europe until the 1400's.

The first European printers did not make books. Instead, they made playing cards, which were in great demand. An artist carved a raised image of a card on a block of wood. Then a printer inked the raised image and pressed a blank card against it. The picture was transferred to the card. Printers soon used this method called *block printing*, to make books as well as cards. But it took a long time to carve every word on blocks.

The invention of movable type made printing much faster because the same carved letters could be used over and over again. After printing a page, the printer could separate the pieces of type and rearrange them.

Printing with movable type had existed in Asia since the 1000's, but the invention did not spread to Europe at that time. Most historians consider Johannes Gutenberg a German metalsmith, to be the inventor of movable type in Europe. In the mid-1400's, Gutenberg brought together several inventions to create a whole new system of printing. He made separate pieces of metal type, both capitals and small letters, for each letter of the alphabet. He lined up the pieces of type in a frame to form pages. Gutenberg created his own ink from paint, dye, and other substances. Finally, he rebuilt a wine press to make the first printing press in Europe. Gutenberg had

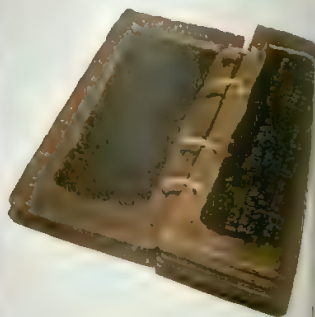
Highlights in the history of communication



Smoke signals were one of the earliest forms of long-distance communication. Such signals could send only limited information—a warning, for example.



Cuneiform writing consists of wedge-shaped characters stamped on clay. The clay cylinder above was inscribed during the 500's B.C. in Babylon.



Wax tablets were once a common writing surface. The early Greeks wrote on such tablets with a pointed tool called a *stylus* and laced the tablets together.

found it hard to produce evenly printed copies by hand, but the new printing press made it possible to put uniform pressure on the paper.

Printing quickly became the most important means of mass communication, and the art of hand copying died out. However, many people feared that the new art of printing was black magic that came from the Devil. They did not understand how books could be produced so quickly, or how all copies could look exactly alike. To soothe people's fears, early printers concentrated on producing Bibles and religious books rather than scientific works or other writings.

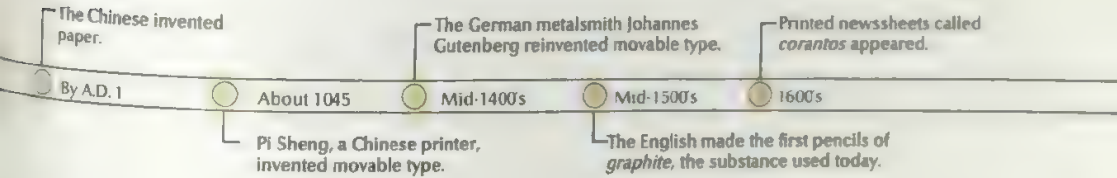
The large numbers of printed Bibles made it possible for many people to read the Scriptures for themselves. As a result, some people began to question certain practices of the Roman Catholic Church. In this way, printing helped give birth to the Protestant Reformation of the 1500's. This movement began as an effort to reform the Catholic Church and ended with the establishment of Protestant churches.

The 1600's and 1700's. By the 1600's, the art of printing was also used in business. Printed newsheets called *corantos*, which were somewhat like newspapers, appeared in the Netherlands, England, and other trading nations. The *corantos* reported mostly business news, such as which ships had landed and what goods they carried. The newsheets also printed advertising. The *corantos* soon added nonbusiness news and became the first true newspapers.

The spread of printing continued in the 1700's. Books, magazines, and newspapers made information available to more and more readers. People also exchanged news by letter, and many nations established postal systems. Before the 1700's, most letters were delivered by ship captains or other travellers.

Most communication, however, was no faster in the 1700's than it had been in ancient times. News travelled only as fast as people did, on foot, on horseback, or by ship. Then, in the late 1700's, a French engineer named Claude Chappe developed a means of rapid long distance communication. Chappe devised a visual telegraph similar to that of the ancient Greeks. It consisted of a series of towers between Paris and other European cities. An operator in each tower moved a crossbar and two large, jointed arms on the roof to spell out messages. An observer on the next tower read the messages by telescope and spelled them out in the same way, and so the messages were passed on.

In the early 1800's, many new inventions revolutionized communication. An important advance in printing came in 1811, when a German printer named Friedrich Koenig used a steam engine to power a press. Printers still had to set type by hand, but the actual printing went hundreds of times faster. *The Times* of London first used Koenig's press in 1814. The invention allowed *The Times* and other newspapers to print large numbers of copies cheaply, making mass circulation of newspapers possible.



Detail of an Italian manuscript (about 1331) by Giovanni de' Nusiola. Bibliothèque Nationale, Paris



During the Middle Ages, artists copied books by hand, letter by letter. They covered their work with gold, silver, and coloured decorations called *illumination*.

Printing from movable type was invented in Asia during the 1000's and in Europe during the 1400's. A shop of the 1600's is shown above. On the left, typesetters assemble type to form pages. In the background, an assistant inks a page. On the right, a printer turns a huge screw on the printing press to push paper against the type.

The invention of steamships and locomotives increased the speed at which people and news could travel. But rapid communication did not begin until the invention of the electric telegraph, which sent messages over wires in seconds. Inventors in Denmark, Germany, Great Britain, and other countries built various telegraphs during the early 1800's. But the devices all had two weaknesses. They lacked a constant source of electricity, and they were difficult to use.

During the 1830's, the American painter and inventor Samuel F. B. Morse began work on an electric telegraph. After years of experimenting, Morse and his partner, Alfred Vail, developed a simple telegraph that had a stable current produced by batteries and electromagnets. The device sent messages in a code of dots and dashes known as *Morse code*. Morse patented his invention in 1840. For the first time, news travelled with the speed of electricity. Newspapers began to use the Morse telegraph almost at once. By the 1860's, telegraph lines linked most cities. The telegraph became the chief means of long-distance communication.

The telegraph could send messages only where wires were strung. In 1858, an underwater telegraph cable was laid across the Atlantic Ocean. But the cable failed after a few weeks. The first successful transatlantic cable was laid in 1866, largely due to the efforts of Cyrus W. Field, an American millionaire, and Lord Kelvin, a British physicist. This underwater cable made it possible to send a message across the Atlantic in minutes.

Communication was further aided by the invention of photography. Many American, British, and French scientists contributed to its development, and no one person can be called the inventor of photography. In 1826, a French physicist named Joseph Nicéphore Niépce made the first permanent photograph. Niépce's technique, which he called *heliography*, involved exposing a metal plate to light for about eight hours. As a result, he could only photograph such immovable objects as houses. No image would be formed by a moving object.

The French painter Louis J. M. Daguerre worked as Niépce's partner for several years. In the 1830's, Daguerre developed an improved type of photograph called a *daguerreotype*. A daguerreotype took only a few minutes to be exposed. About the same time, the British inventor William Henry Fox Talbot invented a method of photography that used a paper negative instead of a metal plate. Fox Talbot's invention, which he called a *talbotype* or *calotype*, was not widely used because it produced less clear pictures than a daguerreotype. But the idea of using a flexible negative became the key to modern photography. With other methods, the photographer used glass or metal plates that had to be changed after each exposure. With Fox Talbot's method, the film could be moved through the camera and used to take a series of pictures.

In the late 1800's, a large number of inventions improved communication. These included the typewriter, telephone, phonograph, and motion picture. In 1868,

The French engineer Claude Chappe developed a visual telegraph.

Late 1700's

1811

Friedrich Koenig, a German printer, invented a steam-powered printing press.

Joseph Nicéphore Niépce, a French physicist, made the first permanent photograph.

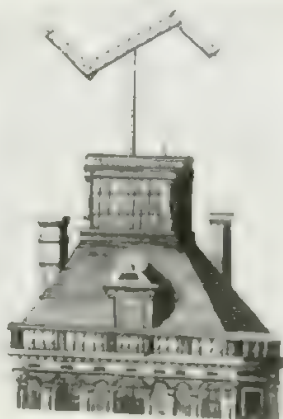
1826

1830's

The French painter Louis J. M. Daguerre developed an improved photograph.



Postal service was established in many countries during the 1700's. This post-rider carried mail between Boston and other cities in the American Colonies.



The Chappe telegraph consisted of a series of towers. An operator in each tower moved a crossbar and two large, jointed arms to send coded messages.



Detail of interior of an Cabinet de Curiosités, Société Française de Photographie, Paris

A daguerreotype was an early type of photograph printed on a metal plate. Louis J. M. Daguerre took this picture of a collection of rare objects in 1837.

Carlos Glidden, Christopher Latham Sholes, and Samuel W. Soule, three American partners, patented the first practical typewriter. E. Remington and Sons, the manufacturer of the famous Remington rifle, began to produce the typewriter in the mid-1870's.

Alexander Graham Bell, a Scottish-born teacher of the deaf, patented a kind of telephone in 1876. Bell's device made it possible to transmit the human voice over wires. Elisha Gray, an American inventor, patented a similar machine about the same time. But the first telephone network, which was built in New England in 1878, used Bell's design. By 1890, the Bell telephone system was widely used in the United States and Europe.

In 1877, the American inventor Thomas A. Edison invented the first practical phonograph. It recorded sound on a cylinder covered with foil. About 10 years later, Emile Berliner, a German immigrant to the United States, invented a phonograph that used discs instead of cylinders. By the early 1900's, Berliner's disc phonograph had replaced Edison's model.

Until the 1880's, printers set type entirely by hand, just as Gutenberg had done. Then in 1884, Ottmar Mergenthaler, a German mechanic in the United States, patented the Linotype machine. The Linotype used a keyboard to set type mechanically, eliminating the need for hand setting. The invention speeded up the production of newspapers and other publications.

In 1887, an American clergyman named Hannibal W. Goodwin developed a Celluloid film that was tough but

flexible. George Eastman, a manufacturer of photographic equipment, introduced the film in 1889. Using Eastman film, Edison and other inventors succeeded in making and projecting motion pictures during the 1890's. Edison probably bought his design for a film projector from the American inventors Thomas Armat and Charles Francis Jenkins.

The beginning of the electronic age, near the end of the 1800's, revolutionized communication once again. At that time, the only means of quick long-distance communication were the telegraph and the telephone, both of which could send messages only along wires. During the electronic age, inventors used a branch of science and engineering called electronics to send signals through space. The electronic age made possible the invention of radio, television, and other wonders of modern communication.

Electronic communication developed from the ideas and experiments of several scientists. In 1864, the British physicist James Clerk Maxwell theorized that electromagnetic waves travelled through space at the speed of light. In the late 1880's, the German physicist Heinrich Hertz performed experiments that proved the existence of these waves. Hertz could not see any practical application for his research. But in 1895, an Italian inventor named Guglielmo Marconi combined the ideas of Maxwell, Hertz, and others to send signals through space. Marconi called his device the *wireless telegraph*. We call it radio.

The American painter Samuel F. B. Morse patented his electric telegraph.

The first successful transatlantic telegraph cable linked Europe and North America.

Alexander Graham Bell patented a type of telephone.

1840

1864

1866

1868

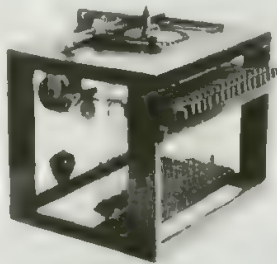
1876

The British physicist James Clerk Maxwell reported his theory of electromagnetism, which led to radio.

Three American inventors patented the first practical typewriter.



Samuel F. B. Morse developed one of the first successful electric telegraphs. He also developed Morse code, a system of sending messages by dots and dashes.



An early typewriter was patented in the 1860's by three American inventors—Carlos Glidden, Christopher Latham Sholes, and Samuel W. Soule.



Alexander Graham Bell designed one of the first successful telephones and demonstrated it at the 1876 Centennial Exposition in Philadelphia.

At first, only Morse code signals were sent by Marconi's device. In 1906, Reginald A. Fessenden, a Canadian-born physicist, attached a telephone mouthpiece to a wireless telegraph and became one of the first persons to transmit speech. On Christmas Eve in 1906, several radio operators picked up Fessenden's first broadcast. They were shocked to hear Christmas music and a Bible reading instead of the *dit-dah-dit* of Morse code.

During the early 1900's, Lee De Forest of the United States and certain other electrical engineers developed various devices called *vacuum tubes*, which could detect and amplify radio signals. Vacuum tubes made possible the development of radio as we know it.

Experimental radio stations, many of which were connected with engineering schools or universities, appeared as early as 1908.

Radio stations soon sprang up in many countries. In 1922, station WEAJ in New York City accepted a fee to allow a company selling apartments to advertise on the air. The United States developed a system of commercial radio—and later television—in which most programmes are paid for by advertisers. In most other countries, radio and TV networks get much of their funds from the government.

The development of modern communication. Television, like many other inventions, originated from the research and thinking of many people. Attempts to send pictures through space date back to the 1800's. A working system was developed in 1926, when John

Famous first words

"What hath God wrought!" Samuel F. B. Morse sent this message from Washington, D.C., to Baltimore over the world's first commercially practical telegraph line on May 24, 1844

"Glory to God in the highest, on earth peace, good will to ward men." This message of Aug. 16, 1858, was the first official communication sent over a transatlantic cable.

"Mr. Watson, come here. I want you!" Alexander Graham Bell spoke these words, the first communication by telephone, on March 10, 1876. Bell had accidentally spilled a jar of acid and was calling for his assistant, Thomas A. Watson

"Mary had a little lamb. . ." Thomas A. Edison recited this verse, the first phonograph recording, in 1877

"S." Guglielmo Marconi received this signal, the first transatlantic wireless message, on Dec. 12, 1901.

"Wait a minute, wait a minute. You ain't heard nothin' yet." Al Jolson spoke these words in the first partly talking film, *The Jazz Singer* (1927).

"That's one small step for a man, one giant leap for mankind." United States astronaut Neil Armstrong spoke these words on July 20, 1969, as he became the first person to set foot on the moon.

Logie Baird, a Scottish engineer, demonstrated the possibility of television transmission. In 1936, the British Broadcasting Corporation (BBC) transmitted the world's first open-circuit TV broadcasts. The Radio Corporation of America (now RCA Corporation) began regular telecasts in 1939. RCA used an improved TV camera and electronic picture tube perfected by Vladimir K. Zworykin, a Russian-born American physicist.

Thomas A. Edison developed the first practical phonograph.

Ottmar Mergenthaler, a German-born mechanic, patented the Linotype machine.

1877

1880's

1884

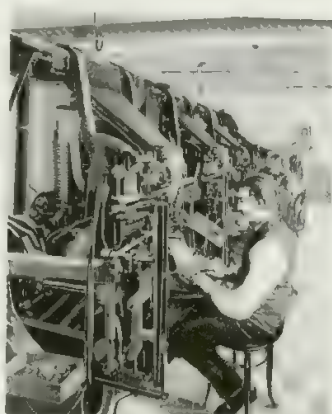
1895

The German physicist Heinrich Hertz discovered electromagnetic waves.

The Italian inventor Guglielmo Marconi developed the *wireless telegraph* (radio).



Thomas A. Edison's phonograph recorded sound on a cylinder covered with foil. This picture shows the inventor with an early version of his phonograph.



Linotype machines used a keyboard to set type mechanically. Their introduction speeded up the production of newspapers and other publications.



Guglielmo Marconi combined the ideas of several scientists to send signals through the air. His invention, the *wireless telegraph*, led to present-day radio.

Television programmes were suspended in the early 1940s, during World War II. But broadcasting resumed after the war. By the early 1950s, TV stations had sprung up in the United States and Europe.

In the late 1800s, a Danish engineer named Valdemar Poulsen had invented a machine that recorded sounds on steel wire. But Poulsen's invention gained little attention. During the 1930s, German engineers developed recorders that recorded sounds on magnetic tape. Unlike a phonograph recording, a tape recording could be played back immediately after being made.

Videotape recorders, developed during the 1950s, recorded pictures as well as sound on magnetic tape. At first, only TV stations used videotape recorders. But cassette videotape recorders, developed during the 1970s, made such recording cheap enough for home use. By plugging the cassette videotape recorder into their TV sets, people could automatically record programmes for later viewing. In the early 1980s, several companies introduced *videodiscs*. The pictures and sounds prerecorded on the videodiscs are transmitted by a special player to an attached TV set.

Artificial earth satellites called *communications satellites* first relayed messages between ground stations in 1960. Before that time, TV signals could only be sent by cable or where there were relay towers to reinforce the signals. Satellites made it possible to relay TV signals across oceans. The satellites could also transmit radio, telephone, and other communication.

During the 1970s, many newspapers and other publications began to use computerized editing and typesetting systems. Instead of using typewriters, writers and editors type articles on keyboards linked with a computer. As they type, the words are simultaneously stored in the computer and displayed on a VDT. In turn, the computer is connected to a device called a *photocomposition machine*. At the touch of a button, the machine sets the article in type on photographic film.

In the early 1980s, several companies began marketing *cellular mobile telephones*. In a cellular telephone system, a city is divided into districts called *cells*, each of which has a low-powered radio transmitter and receiver. As a phone-equipped car travels from cell to cell a computer transfers a call from one transmitter and receiver to another without interrupting the conversation.

By the late 1980s, many businesses had begun to use a process called *facsimile*, or *fax*, to speed communication. A fax machine sends and receives copies of documents over telephone lines. It can reproduce both text and pictures.

Communication of the future probably will involve many forms of light-wave energy and *lasers*, devices that produce a narrow beam of intense light. Even today a branch of physics called *fibre optics* has made it possible to use light to send more messages faster than could be done with electricity or radio waves. With fibre-optic communication, a laser beam transforms the electric signals of a telephone call or TV picture into

Reginald A. Fessenden, a Canadian-born physicist, transmitted voice by radio.

Vladimir K. Zworykin, a Russian-born physicist, demonstrated the first all-electronic TV system.

1906

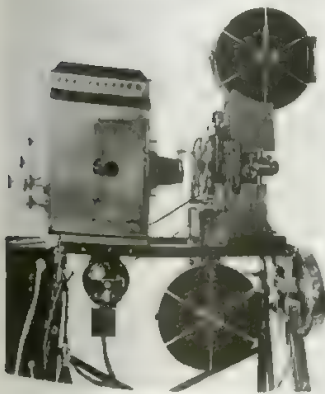
1907

1929

1936

The American inventor Lee De Forest patented the *triode*, an improved vacuum tube.

The British Broadcasting Corporation made the world's first TV broadcasts



A film camera of about 1915 was used to shoot silent films. Several inventors developed film cameras in the late 1800s and early 1900s.



Radio became a major source of family entertainment during the 1920s. This photograph shows a singer making a broadcast during the early days of radio.



One of the first TV broadcasts was a demonstration of self-defence techniques. It appeared in 1936 on the British Broadcasting Corporation (BBC).

light impulses. The laser is aimed into one end of a thin, transparent glass strand called an *optical fibre*. The light can travel great distances through the fibre without losing strength or clarity. At the receiving end, a device changes the laser light back into the original sounds and pictures. A bundle of optical fibres, each about the thickness of a human hair, can transmit thousands of telephone calls or TV programmes at the same time.

Lasers are also used in a method of three-dimensional photography called *holography*. A device called a *beam splitter* divides laser light into two beams, one of which is aimed at the object to be photographed. Then, mirrors bring the beams of light back together again. Where the two beams come together, they form a three-dimensional pattern that corresponds to the shape of the object. Holography eventually may be used to produce films, photographs, and TV programmes consisting of three-dimensional images that float in space. Viewers will be able to walk around the holographic images as if they were real scenes, seeing new angles as they move.

The study of communication

The study of communication is not a single branch of education. Instead, it involves many fields of study. The scholars who explore communication include educators, historians, linguists, mathematicians, neurologists, psychologists, and sociologists. Most of these scholars study only a few aspects of communication. Others de-

vote themselves to an overall study of the field. For example, the Canadian educator Marshall McLuhan has become known for his studies of mass communication. McLuhan explored the effects of mass media on society in several books, including *The Gutenberg Galaxy* (1962) and *Understanding Media* (1964).

The major areas of communication study include (1) sociology and psychology, (2) linguistics, (3) cybernetics and information theory, and (4) the study of nonverbal communication.

Sociology and psychology produced the first academic studies of mass communication during the 1930's. Two American sociologists, Paul F. Lazarsfeld and Frank Stanton, studied the audiences of various radio programmes. Their work encouraged other U.S. researchers, including social psychologist Hadley Cantril and sociologist Robert K. Merton, to investigate the effects of radio and TV broadcasting on the public.

During World War II, the warring nations conducted widespread propaganda operations. As a result, many scholars began to study propaganda and public opinion. Carl I. Hovland, an American psychologist, investigated how persuasive communication causes people to modify their beliefs. After the war ended in 1945, many scholars studied the effects of mass communication on individuals and society.

Linguistics is the scientific study of language. One of the most important developments in linguistics was the introduction of *transformational grammar* during the

Bell Telephone Laboratories developed the transistor.

1947

Television networks began to record programmes on videotape.

Mid-1950's

Xerox Corporation perfected *xerography*, a copying process.

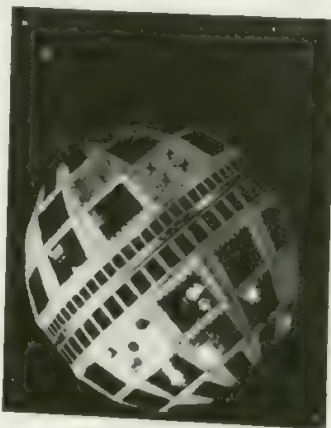
1960

Dennis Gabor, a British engineer, invented *holography* (3-D photography).

Echo 1 became the first satellite to receive radio signals from a ground station and reflect them back to earth.



Tape recorders that recorded sounds on magnetic tape were developed by German engineers during the 1930's. This recorder dates from 1948.



Telstar 1, a communications satellite launched in 1962, relayed telephone calls, TV shows, and other communications between the United States and Europe.



Computers revolutionized communication in the 1960's and 1970's. A computer terminal at an airport, above, relays information about flights and reservations.

1950s by the American linguist Noam Chomsky. Transformational grammar consists of rules that determine all the sentences that can possibly be formed in any language. Chomsky found that the languages of the world are similar in more ways than they are different and that certain principles are true of all languages. These discoveries led him to believe that everyone has the potential for learning the general rules of language at birth.

Another important field of linguistics is *semantics*, which analyses the meanings of words and the communication problems created by language. Scholars who contributed to the growth of semantics include Alfred Korzybski, a Polish-American scientist, and S. I. Hayakawa, an American educator.

Cybernetics and information theory. A science called *cybernetics* is the study of how information is transmitted by the nervous systems of living things and by the control mechanisms of machines. An important part of cybernetics is the study of *feedback*, the process by which devices and organisms regulate themselves. Cybernetics was developed by the American mathematician Norbert Wiener, whose book *Cybernetics* was published in 1948.

A related science called *information theory* was developed about the same time by two other American mathematicians, Claude E. Shannon and Warren Weaver. Information theory deals with the mathematical laws that govern communication, especially the factors that interfere with the transmission of a message. Cybernet-

ics and information theory have played important roles in the development of computer science.

The study of nonverbal communication is probably the oldest area of investigation into human communication. It dates from at least the 1800s, when teachers of acting and pantomime analysed how facial and body movements could be used to convey emotion.

The modern study of nonverbal communication sometimes called *body language*, includes two sciences called *kinesics* and *proxemics*. Kinesics is the study of body and facial movements as an accompaniment to speech. Kinesics was developed by an American anthropologist named Ray Birdwhistell. Birdwhistell used slow-motion films of speakers to analyse their gestures and expressions.

The science of proxemics was developed by the American anthropologist Edward Hall. Hall studied how people in different cultures use gestures, posture, speaking distance, and other nonverbal signals to communicate their feelings and social status. People would feel uncomfortable putting most of such information into words. But proxemics allows people to send and receive messages without the use of words.

Related articles in World Book.

Communication devices and media

Alphabet	Daguerreotype	Holography
Book	Fibre optics	Language
Cable	Film industry	Laser
Citizens band radio		

1970 Corning Glass Works produced the first optical fibre suitable for long-range communication.

1974 The first telegram was transmitted by satellite.

1970

1970s

1974

Early 1980s

Several manufacturers developed cassette videotape recorders.

Several companies began marketing cellular mobile telephones.



Fibre-optic communication uses a laser to send signals through glass strands called *optical fibres*, shown above.



A home computer, above, helps a girl practise arithmetic problems. Small computers that perform a variety of jobs gained popularity in the late 1970s.



A cellular mobile telephone enables a motorist to make and receive calls. These devices, introduced in the 1980s, greatly improved mobile phone communication.

Linotype	Radio	Teletprinter
Magazine	Record player	Television
Newspaper	Satellite, Artificial	Transistor
Photography	Talibotype	Typewriter
Pony express	Tape recorder	Vacuum tube
Post office	Telecommunication	Videodisc
Printing	Telegraph	Walkie-talkie
Publishing	Telephone	Writing

Inventors

Baird, John L.	Jenkins, Charles Francis
Bell, Alexander Graham	Kelvin, Lord
Berliner, Emile	Land, Edwin H.
Cornell, Ezra	Lumière brothers
Daquerre, Louis J. M.	Marconi, Guglielmo
De Forest, Lee	Maxwell, James Clerk
Dolbear, Amos E.	Mergenthaler, Ottmar
Eastman, George	Morse, Samuel
Edison, Thomas A.	Finley Breese
Farnsworth, Philo T.	Niépce, Joseph N.
Gabor, Dennis	Pupin, Michael I.
Glidden, Carlos	Sholes, Christopher L.
Gray, Elisha	Siemens (Werner von)
Gutenberg, Johannes	Wheatstone, Sir Charles
Hertz, Heinrich R.	Zworykin, Vladimir K.

Organizations

American Telephone and Telegraph Company	Reuters
Associated Press	Tass
British Broadcasting Corporation	United Press International
	Western Union Telegraph Company

Other related articles

Advertising	Propaganda
Cybernetics	Public opinion
Information theory	Public relations
Journalism	Semantics
Kinesics	Speech
Linguistics	Symbol
McLuhan, Marshall	

Outline

I. The importance of communication

- A. At home
- B. At school
- C. In business and industry
- D. In world affairs

II. The development of communication

III. The study of communication

- A. Sociology and psychology
- B. Linguistics
- C. Cybernetics and information theory
- D. The study of nonverbal communication

Questions

- What were the words of the first phonograph recording? Who spoke them?
- How did the invention of printing contribute to the religious movement called the Protestant Reformation?
- What two inventors developed movable type independently in Asia and in Europe?
- What means of long-distance communication was used both in ancient Greece and in France in the 1700's?
- What are the two different methods by which radio and TV broadcasting is paid for?
- What source provides about two-thirds of the news that people hear every day?
- Why might the War of 1812 (between Britain and the United States) be called the War of Faulty Communication?
- How did the Linotype machine speed the production of newspapers and other publications?
- Why was the invention of writing one of the most important events in the history of communication?
- What is the science of *proxemics*?

Communications satellite. See Satellite. **Artificial Communion**, in Christian churches, is the sacrament (holy ceremony) of the Lord's Supper. The Gospels and I Corinthians report that at the Last Supper, Jesus told His disciples to eat, for this was His body, and to drink for this was His blood. Many Protestants call the sacrament the *Lord's Supper*. Anglicans, Roman Catholics, and members of the Eastern Orthodox churches call the ceremony the *Eucharist* or *Holy Communion*. Some Protestant churches observe the ritual monthly or weekly. Others observe it four times a year. Roman Catholics must receive Communion during the Easter season, and often they receive weekly or daily Communion.

Some churches use individual wafers of unleavened bread and, especially among Protestant churches, individual glasses of wine. The modern liturgical movement has proposed celebrating the sacrament more frequently. It also proposes using a shared loaf of bread and a common cup of wine.

Related articles in *World Book* include:

Christianity (Beliefs)	Protestantism (Belief in sacraments)
Eastern Orthodox Churches (Services; Sacraments)	Roman Catholic Church (The seven sacraments)
Mass	Transubstantiation

Communism is a political and economic system that became one of the most powerful forces in the world. It shaped history from the early 1900's to the 1990's.

The term *Communism* has several meanings. Communism can be a form of government, an economic system, a revolutionary movement, a way of life, or a goal or ideal. Communism is also a set of ideas about how and why history moves, and in what direction it is headed. These ideas were developed mainly by V. I. Lenin from the writings of Karl Marx. Lenin was a Russian revolutionary leader of the early 1900's, and Marx was a German social philosopher in the 1800's.

During the 1900's, millions of people lived under Communist rule. In 1917, Russia became the first state to be controlled by a Communist Party. Russia joined with three other territories in 1922 to form the Union of Soviet Socialist Republics (U.S.S.R.), or Soviet Union.

After World War II (1939-1945), Soviet troops occupied most of Eastern Europe. The Soviet Union was thus able to help Communists take power in that region. In 1949, the Chinese Communist Party won a civil war for control of China.

The rapid spread of Communism after World War II brought about a struggle for international power and influence between Communist countries and non-Communist countries. This struggle was known as the Cold War. The collapse of several Communist governments in Eastern Europe in 1989 and the fall of Communism in the Soviet Union in 1991 marked the end of the Cold War. By 1992, Communist parties remained in power in only a small number of countries.

The terms *Communism* and *socialism* are frequently confused. Communists usually refer to their beliefs and goals as "socialist." But socialists do not consider themselves Communists. Communists and socialists both seek public ownership or regulation of the principal means of production. But most socialists favour peaceful and legal methods to achieve their goals, while Communists have often used force. Socialism may or may not

be based on the teachings of Marx. Communism is based on the teachings of both Marx and Lenin.

This article presents a broad survey of Communism in theory and as it was practised in most Communist countries until about 1990. For a detailed description of life under Communism in China and the U.S.S.R., read the *World Book* articles on those countries. For a more complete understanding of how Communism compares with other political or economic systems, see **Capitalism** (How other systems differ from capitalism); **Economics** (Kinds of economies); **Government** (Who governs?); and **Socialism**.

Communism in theory

Communism in the 1900's has been based on the theories of Marx as interpreted and modified by Lenin. These theories are often called *Marxism-Leninism*.

Early communism. The word *communism* comes from the Latin word *communis*, which means *common* or *belonging to all*. The idea of communal property dates at least from the time of the early Greeks. In the 300's B.C., the Greek philosopher Plato discussed communal ideas in his book *The Republic*. Plato proposed that a ruling class own everything in common, putting the welfare of the state above all personal desires. A number of early Christian groups had some form of community ownership of property.

Over the centuries, many philosophers and reformers supported such communist ideals as community ownership and equality of work and profit. Then, in the 1800's, Marx transformed Communism into a revolutionary movement.

The ideas of Marx. Marx's basic ideas were first expressed in the *Communist Manifesto* (1848), a pamphlet that he wrote with Friedrich Engels, a German economist. Marx thought that the only way to ensure the creation of a happy, harmonious society was to put the workers in control.

Marx believed that the triumph of Communism was inevitable. He taught that history follows certain unchangeable laws as it advances from one stage to the next. Each stage is marked by struggles that lead to a higher stage of development. Communism, Marx declared, is the highest and final stage of development.

According to Marx, the key to understanding the stages of historical development is knowing the relationship between different classes of people in producing goods. He claimed that the owners of factories and other means of production—the *ruling class*—use their economic power to force their will on the people. Marx assumed that the ruling class would never willingly give up power, and so struggle and violence were inevitable.

Marx called for the abolition of *capitalism*, an economic system in which the chief means of production are privately owned. Under capitalism, Marx believed, a struggle takes place between the *bourgeoisie* and

the *proletariat*. The bourgeoisie are the owners and managers of the means of production, and the proletariat are the workers. Marx argued that workers do not receive full value for their labour under capitalism, because the owners keep the profits. He believed that, under capitalism, wealth would become concentrated in the hands of a few people, and most people of the middle class would be forced to become workers. The workers' living standards would continuously grow worse.

Finally, the workers would turn away from capitalism and their nation's political system. They would then revolt and seize control of industry and the government.

The workers would first establish a socialist state. Its government would be a *dictatorship of the proletariat*—a government controlled by workers, that would work to establish a classless Communist society. After classes had been eliminated, everyone would live in peace, prosperity, and freedom.

European reality in the early 1900's. By the early 1900's, capitalism was more successful in Europe's industrial nations than Marx had predicted. Economic modernization was causing the middle classes to grow larger rather than smaller. The formation of trade unions increased production of consumer goods, and the growth of democracy had led to a rise in living standards.

During this period, many Marxists began to believe that social justice could be achieved within a democratic system. These moderates, called *democratic socialists*, thought such justice could be brought about by *evolutionary* rather than *revolutionary* means.

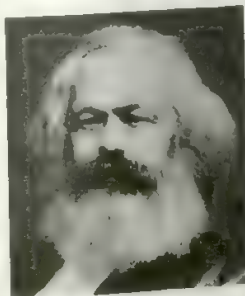
Lenin's contributions. Lenin believed that capitalism in Europe had escaped failure because of *imperialism*—a policy in which one country extends influence over other countries. Capitalists from European imperialist countries underpaid workers they hired in African and Asian colonies. This helped the capitalists produce goods cheaply, which in turn kept prices in Europe low. Low prices contributed to a high standard of living for Europeans, which helped prevent unrest in Europe. But the exploitation of workers in nonindustrial societies created the possibility of a Communist revolution there, which Marx had not foreseen.

Lenin agreed with Marx's idea that only revolutionary violence could bring about political change. But Lenin believed a highly centralized, tightly disciplined *vanguard* (leading group) of professional revolutionaries would lead the revolution. This vanguard would make up the Communist Party. Marx's idea of the dictatorship of the proletariat became, in Lenin's thinking, the dictatorship of the Communist Party, which claimed to represent the proletariat.

Communism in practice

In practice, Communism has varied from one Communist country to another. But until the late 1980's, certain basic features of Communism were shared by all Communist countries.

One of these features was *totalitarianism*. In totalitarian countries, the government controls almost all aspects of people's lives. Communist countries also were *party states*. In a party state, the ruling party dominates all government bodies. The countries had *centrally planned economies*, also called *command economies*.



Karl Marx

economies in which the state owned the means of production and the government planned most economic activity. Finally, Communist countries valued cooperation and *collective* (group) needs over personal freedom. In other words, they considered the well-being of the state and society to be more important than that of the individual.

The role of the Communist Party. The Communist Party performed four important roles in Communist systems. (1) It carefully selected party members. (2) It maintained total control over public policies. (3) It supervised every branch of government. (4) It carefully screened people for key jobs throughout society.

Communist Party structure has varied from country to country. But Communist parties have shared certain basic characteristics.

The traditional Communist Party is structured like a pyramid. At the bottom of the pyramid are numerous local party organizations, formerly called *cells*. In the middle are various regional and district organizations. At the top is a party congress, made up of delegates from party organizations throughout the country.

Party congresses usually meet every three to five years. During meetings, each congress votes on issues facing the country and the party. It also elects the party's Central Committee, an administrative body.

The most powerful decision-making bodies are the Central Committee, the Politburo, and the Secretariat. The Central Committee carries out the work of the party between congresses. It also approves the elections of members to two other administrative bodies, the Politburo and the Secretariat. The Politburo sets all important government policies. The Secretariat manages the daily work of the party. The head of the Secretariat, called the general secretary, is the most powerful person in the party and in the country.

The party state. Marx believed that in a Communist society, the powers of the state—and eventually the state itself—would gradually disappear. But no Communist country ever eliminated the state. Communists believed that a state dominated by the Communist Party was necessary to defend Communist countries against capitalist influence from other countries. Therefore, secret police as well as regular police forces and a strong military establishment would be needed until Communism had been attained worldwide.

In Communist states, all power rested with the Communist Party. The people who led the party also headed the government. The individuals who made up the government *bureaucracy* (the system of officials who carry out governmental functions) were all party members.

The centrally planned economy. Marx predicted that central planning of industrial and agricultural production would guarantee economic efficiency, job security, and income equality. Communist countries therefore *nationalized* (put under government control) factories and farms and established procedures for planning economic activity.

Government planners determined what raw materials would be produced, when and where they would be produced, and what products they would be used to manufacture. The planners also decided to whom and at what prices the finished products would be sold.

Communist economies experienced some success.

Centralization enabled governments to focus their energies and rapidly industrialize their countries. It also helped the Soviet Union build up its military forces. Literacy and employment rates soared in Communist countries. In addition, Communist countries distributed income fairly equally.

The centrally planned economy created serious problems, however, because it was inefficient. State-set prices did not reflect the actual cost of production, leading to waste of resources. The planned economy also failed to provide high-quality goods and services and could not respond quickly to changes in consumer demand. Workers had little motivation to be productive because their wages remained about the same regardless of how much they produced.

In addition, the economy was not as fair as it may have appeared. Communist Party leaders and members of the bureaucracy enjoyed privileges denied to other citizens. These people and their families had special access to government cars, well-stocked grocery stores, comfortable housing, and better health care.

Restrictions on personal freedom. Communist leaders traditionally considered the needs of society more important than individual rights and liberties. As a result, personal freedoms were severely restricted. The amount of police repression varied, however. For example, when Joseph Stalin was dictator of the Soviet Union from 1929 to 1953, millions of Soviet citizens were executed or sent to labour camps. The government also ordered people to spy on their neighbours and family members. Stalin adopted these measures to eliminate real and imagined opposition to his policies. Similar conditions existed in China under Mao Zedong, who ruled that country from 1949 to 1976.

After Stalin's death in 1953, most Communist governments shifted from open terror to more subtle forms of repression. For example, they threatened to dismiss people from their jobs or to deny them new housing if they opposed the government. Governments also used material rewards to encourage obedience. A similar transition occurred in China after the death of Mao.

In Communist countries, individuals were not allowed to publicly criticize Communist Party leaders or policies or to openly oppose the Communist system. Governments also did not permit people to establish organizations or publications that opposed Communism. In addition, writers who were critical of Communism were not allowed to publish their work. All these restrictions existed despite the fact that many Communist governments had constitutions claiming to guarantee the freedoms of speech, press, and assembly.

Communists in most countries discouraged religious worship because they considered religion a threat to Communism. Church members found it more difficult to advance in their jobs and were not allowed to join the Communist Party.

Communism in the Soviet Union

Before 1917. Marx had expected his theories to be tested in Germany, the United Kingdom, or some other highly industrialized country. But it was in relatively agricultural Russia that Communists first succeeded in setting up a Communist-controlled government.

During the late 1800's, Russia began to modernize. As

industrialization increased, discontent grew among the rising middle class and workers in the cities. In addition, a series of bad harvests in the 1890's caused starvation among the peasants. Revolutionary activity grew, and radical ideas—including Marxism—became popular.

In 1898, Marxists founded the Russian Social Democratic Labour Party. The party split into two groups in 1903. The Bolsheviks, led by Lenin, accepted his idea of a small Communist Party made up of professional revolutionaries. The Mensheviks wanted the party to have wider membership and to reach decisions through democratic methods.

In 1917, the Russian people overthrew the czar. A democratic *provisional* (temporary) government was set up. In autumn 1917, the Bolsheviks, led by Lenin, seized power and established a Communist government.

Under Lenin. Lenin led Russia from 1917 until his death in 1924. For a short time, Lenin let the peasants keep farmland they had seized. He permitted workers to control the factories and to play important roles in local government. But the government soon tightened control and forced the peasants to give the government most of their products. The government also took over Russian industries and set up central management bureaus to run them. In addition, the state created a secret police force called the Cheka.

From 1918 to 1920 Russia was torn by civil war between Communists and non-Communists. The Communists defeated their rivals, who were divided and poorly organized. From the start, Lenin used force and terror against his political opponents. By 1921, conditions had become disastrous throughout the country. Peasant and sailor revolts broke out, and famine threatened. World War I (1914-1918), revolution, and civil war had brought Russia close to economic collapse.

In 1921, Lenin introduced the New Economic Policy (NEP). The NEP called for Communists to cooperate with certain groups who were considered enemies of Communism. These included shopkeepers, peasants, engineers, scholars, and army officers. Russia's economy recovered steadily under the NEP. In 1922, the country became known as the Union of Soviet Socialist Republics (U.S.S.R.), or the Soviet Union.

By the time Lenin died in 1924, the Soviet Union had become a one-party state. All non-Communist political parties had been banned, and all public organizations—such as professional associations and trade unions—had become tools of the Communists. See **Lenin, V. I.**

Under Stalin. After Lenin died, leading Communists in the Soviet Union struggled for power. Joseph Stalin gained complete control of the Communist Party and the Soviet government by 1929. Until his death in 1953, he ruled with an iron hand. The Soviet Union's economy and influence abroad grew rapidly—but at a great cost in human life and personal freedom at home.

Stalin established a centrally planned economy



Joseph Stalin

and, in 1928, began the *five-year plans*. These were comprehensive economic plans for the country. The first plan included a programme that combined small peasant farms into *collective farms*, large farms owned and controlled by the government. In the early 1930's, Stalin ordered millions of peasants murdered or exiled when they resisted giving their land to collective farms.

Many other people opposed Stalin's policies during the 1930's. To crush this opposition, Stalin began a programme of terror called the Great Purge. Communists suspected of opposing Stalin or his policies were executed or imprisoned. See **Stalin, Joseph.**

Under Stalin's successors. Shortly after Stalin died in 1953, Nikita Khrushchev became head of the Soviet Communist Party. In 1958, Khrushchev also became the head of the Soviet government. He strongly criticized Stalin for his rule by terror. Khrushchev relaxed political control over writers, artists, and scholars. He also introduced reforms designed to improve the productivity and efficiency of the economy. But the reforms resulted in only slow gains.

In 1964, Communist Party officials forced Khrushchev to retire. Leonid Brezhnev replaced Khrushchev. Brezhnev reestablished many of Stalin's rigid cultural and economic policies but did not return to rule by terror.

After Brezhnev's death in 1982, two other leaders briefly headed the government and the party. But no major changes were enacted until Mikhail Gorbachev became head of the country in 1985. Gorbachev's reform policies and the eventual collapse of Soviet Communism are discussed later in this article, in the section *The decline of Communism*.

The spread of Communism

The Comintern. The Bolsheviks thought the Russian Revolution of 1917 would spark revolution in other countries. But Lenin soon realized that worldwide revolutions would require careful organization. In 1919, he established the *Comintern* (Communist International). The Comintern united all Marxist groups throughout the world who accepted Lenin's ideas on revolutionary violence and Communist Party organization. The only Communist government established with the help of the Comintern was in Outer Mongolia (now called Mongolia) in the early 1920's.

World War II. The international instability that resulted from World War II provided opportunities for



Soviet troops occupied many Eastern European countries in the mid-1940's. Their presence enabled the U.S.S.R. to set up Communist-controlled dictatorships in some of the countries.

Communist gains in many countries. In 1939, the Soviet Union and Germany signed a *nonaggression pact*, an agreement in which they promised not to attack each other. In 1939 and 1940, the Soviet Union took over the Baltic countries of Latvia, Lithuania, and Estonia, and parts of Poland, Finland, and Romania. All of this territory became part of the Communist Soviet Union.

Toward the end of the war, the Soviet Union helped free many countries from German and Japanese control. The presence of Soviet troops enabled the U.S.S.R. to set up Communist-controlled governments in several of these countries, including Bulgaria, East Germany, Hungary, Poland, Romania, and North Korea. Winston Churchill, the former UK prime minister, warned in 1946 that an "iron curtain" had descended across Europe.

In some other countries, Communists who had led national resistance movements during World War II grew stronger. Local Communists took over the governments of Albania, Yugoslavia, and Vietnam near the end of the war with little or no help from the Soviets. A Soviet-supported Communist regime gained complete control in Czechoslovakia in 1948. Communists also became important political forces in France and Italy.

In China, the Communists and the ruling Nationalist Party both fought the Japanese, who had invaded the country during the 1930's. After World War II, a civil war broke out in China between the Communists and the Nationalists. By 1949, the Communists, led by Mao Zedong, had taken over mainland China.

From the late 1940's to the 1960's, most other attempts by Communists to take power failed. Malaya (now part of Malaysia), and the Philippines fought guerrilla wars but failed to gain power. Armed forces from Communist North Korea invaded non-Communist South Korea in 1950. The invasion resulted in a three-year war between the North Koreans and the South Koreans. Neither side won complete victory in the Korean War (1950-1953), and Korea remained divided between a Communist north and a non-Communist south.

The only major gain by Communists during this period occurred in Cuba. Fidel Castro became dictator of Cuba in 1959, and two years later, he declared his government to be Communist.

Expansion in Southeast Asia. In 1946, the Communist leader Ho Chi Minh led a nationalist uprising in the colony of French Indochina. By 1954, Indochina had been divided into Communist North Vietnam, non-

Communist South Vietnam, and neutral Cambodia and Laos. Communists in Cambodia, Laos, and South Vietnam continued to fight the new non-Communist or neutral governments.

The struggle in South Vietnam developed into a major conflict, the Vietnam War (1957-1975). The United States sent troops to support South Vietnam. A cease-fire agreement ended U.S. participation in 1973, but the war continued until the Communists won full control of South Vietnam in 1975. In 1976, the Communists unified North and South Vietnam into the single nation of Vietnam. Communists also conquered Cambodia in 1975. In Laos, Communists came to power in 1975.

Communist influence in other areas. In 1975, leftist guerrilla forces formed Marxist-Leninist governments in Angola and Mozambique. They controlled the governments of these countries until 1990. Other African nations had Marxist-Leninist governments for short periods in the 1970's and 1980's. In Central America, an alliance of Marxist-Leninist groups called the Sandinista National Liberation Front held power in Nicaragua from 1979 to 1990.

In southwestern Asia in 1978, a Marxist-Leninist party seized power in Afghanistan. However, many Afghans rebelled against the new government. In 1979, the Soviet Union sent troops into Afghanistan to prevent the overthrow of the government. The invasion resulted in a lengthy conflict between Soviet troops and Afghan rebels. The Soviet occupation of Afghanistan ended in 1989. The rebels overthrew the government in 1992.

The Cold War

Beginning after World War II, the United States and the Soviet Union competed with each other for international influence and allies in the Cold War.

The Cold War was characterized by mutual distrust, suspicion, and misunderstandings between the two sides. These conditions led to occasional confrontations. In 1962, the United States learned that the Soviet Union had secretly installed missile stations in Cuba that could launch nuclear attacks on cities in the U.S. After a week of extreme international tension, the Soviet Union agreed to United States demands that the missiles be removed. For more examples of Cold War events, see **Cold War**.

Alarmed by Communist expansion in Eastern Europe and in China, the United States and its allies began giv-



Chinese Communists, led by Mao Zedong, defeated China's Nationalist government in a war from 1946 to 1949. Mao is shown here on horseback, moving across central China in 1947.



Fidel Castro, left, declared Cuba to be Communist and began to receive Soviet support. Castro is shown above signing an agreement with Soviet leader Nikita Khrushchev.



Communist Viet Cong guerrillas from North Vietnam march in South Vietnam. In 1975, the Communist North defeated the non-Communist South in the Vietnam War.

ing military and economic aid to non-Communist countries. They also pledged to help nations threatened by Communist take-overs. In 1949, Western nations formed the North Atlantic Treaty Organization (NATO). This alliance provided its members with mutual defence against a possible attack by the Soviet Union or any other aggressor. In 1955, the Soviet Union and its Eastern European allies signed the Warsaw Pact, a treaty to provide for their common defence. Each side invested in a massive arms race, a competition to acquire nuclear weapons and other arms.

In the 1950's, fear of Communism in the United States led to widespread accusations and investigations of suspected Communist activities. This pursuit of Communists came to be called *McCarthyism*, after Senator Joseph McCarthy, a Wisconsin Republican. McCarthy charged that many individuals were Communists or Communist sympathizers, usually with little evidence to support his charges. Nevertheless, many people lost their jobs or suffered lasting career damage as a result of such accusations. See *McCarthyism*.

The decline of Communism

By the late 1970's, Communism was in crisis in many parts of the world. The population of Communist China had almost doubled under Mao Zedong, and the Chinese government was barely able to provide adequate food for its people. Dissatisfaction with Communism in the Soviet-controlled countries of Eastern Europe was growing stronger.

The Soviet Union was confronted with serious economic problems, a dissatisfied middle class, and disappointment with the Communist political system among key members of the political elite. Hostility among the country's numerous ethnic groups had smouldered for years. Many non-Russians resented the power of ethnic Russians and began to demand more control over their own affairs. In addition, corruption was growing among members of the Communist Party bureaucracy. In Western Europe, Communist parties faced declining electoral support by the late 1970's.

By the late 1980's, most Communist countries had experienced long periods of little or no economic growth. Centralized planning proved to be inefficient, and it hindered the development of new technologies. As a result, most Communist countries could not compete economically with non-Communist industrial powers.

The Soviet Union under Gorbachev. Mikhail Gorbachev became head of the Soviet Communist Party in March 1985. When he took power, the Soviet Union faced a declining economy burdened by heavy military expenses. These expenses included maintaining troops in Eastern Europe, supporting unpopular leftist regimes in developing countries, and competing in the arms race. In addition, aging industrial equipment contributed to economic inefficiency.

Dissatisfaction with the Communist system attracted many people to the Western way of life. Gorbachev and members of the Communist Party elite observed the West while travelling there. Other people learned about non-Communist countries through the media.

In response to the U.S.S.R.'s problems, Gorbachev began a programme of reform. First, he introduced *perestroika*, or restructuring of the Soviet political and economic systems. Political reforms included the legalization of non-Communist parties and candidates and the creation of a functioning parliament. Economic reforms included lifting the ban on private businesses run by families and individuals, and modifications in the central planning system. To help win popular support for reform, Gorbachev increased freedom of expression in a policy called *glasnost* (openness).

Gorbachev also worked to improve Soviet relations with other countries. In 1987, he and U.S. President Ronald Reagan signed a treaty that called for the dismantling of all ground-launched Soviet and U.S. intermediate-range nuclear missiles. Relations with the United States also improved when the U.S.S.R. withdrew its troops from Afghanistan in 1989. Gorbachev's acceptance of the collapse of Communism in Eastern Europe further reduced tensions with the West.

Gorbachev was chosen for the new office of president of the U.S.S.R. in 1990. But his policies had begun to provoke the opposition of hard-line Communists in the party. His plans to give the 15 republics of the Soviet Union more control over their own affairs further angered the conservatives. In August 1991, leading hard-line Communist officials staged a coup against Gorbachev and removed him from power. However, the coup soon failed, and Gorbachev resumed his duties. Shortly after returning to power, Gorbachev resigned as the party's head but remained president of the national government. He also ordered the suspension of all Communist Party activities.

By late 1991, most of the republics that made up the Soviet Union had declared independence. In December, 11 republics joined to form a loose organization called the Commonwealth of Independent States. Gorbachev resigned as head of the Soviet government, and the Soviet Union formally ceased to exist.

China after Mao. The Chinese economy was highly inefficient by the time Mao died in 1976. This was largely because of the failure of centralized planning, begun in the 1950's. After Mao's death, a group of economic reformers led by Deng Xiaoping took control of the Chinese Communist Party. The new leadership allowed a return to private farming and the formation of small private businesses, such as tailor shops and restaurants. The government also reversed its policy of refusing foreign investment. It designated many coastal areas as *special economic zones* where foreign investors could

produce consumer goods for export. These reforms resulted in substantial economic growth and in an improvement in living standards for many people.

The Deng regime maintained Communist Party control over the political system, however. In the late 1980's, many Chinese university students began demanding political reforms. In 1989, hundreds of thousands of students and workers demonstrated in Beijing's Tiananmen Square and in several other cities. They called for increased democracy and an end to corruption in government. However, the Chinese military crushed the demonstrations, and many protesters were killed. Shortly afterward, Communist Party and secret police controls were tightened.

In Eastern Europe, many people had always opposed Communism. Over the years, some Communists there also began to resist Soviet domination. In Hungary, some of these Communist reformers joined non-Communists in an uprising against Soviet control in 1956. Soviet armed forces invaded Hungary, put down the rebellion, and installed a new Communist regime. Soviet armed forces also crushed strikes and riots in East Germany in 1953.

The Communist government of Czechoslovakia, led by Alexander Dubček, adopted a reform programme in 1968. The programme included some genuine political competition and less centralized planning. Soviet leaders, fearful of losing control over Czechoslovakia, ordered troops into the country. Under pressure from the U.S.S.R., the Czechoslovak Communist Party replaced Dubček with a rigid pro-Soviet government in 1969.

In 1980, workers in several cities in Poland formed a free trade union organization called Solidarity. In 1981, the Polish government imposed martial law and suspended Solidarity's activities. The Polish government officially outlawed the organization the following year.

In 1989, Communist parties began to lose control over the governments in four Eastern European countries that had been dominated by the Soviet Union since the late 1940's. These countries were Poland, Hungary, East Germany, and Czechoslovakia.

The Polish ban on Solidarity ended in 1989. That year, negotiations between Solidarity and the government led to partially free elections in which pro-Solidarity and other non-Communist candidates won control of the legislature. A coalition government was set up in the summer of 1989. It was the first Polish government since World War II not controlled by Communists.

Also in 1989, thousands of East Germans went to West Germany by crossing over a newly opened border between Hungary and Austria. Anti-Communist demonstrations soon followed in East Germany, and its hard-line Communist leadership resigned. In November, the country opened its long-closed borders with the West.

The disintegration of Communist authority in East Germany sparked anti-Communist demonstrations in Czechoslovakia. These quickly brought about the downfall of the Communist government, and members of liberal opposition groups took power. In Romania, a bloody revolt led to the execution of Communist dictator Nicolae Ceausescu. A group of former Communist Party members and officials called the National Salvation Front took control of the country. Communists who favoured reforms also took power in Bulgaria.

In 1990, free multiparty elections were held in Czechoslovakia, Hungary, East Germany, Romania, and Bulgaria. Non-Communist parties came to power in Czechoslovakia, Hungary, and East Germany. Unification of East and West Germany took place on Oct. 3, 1990. In Romania, the winning group was the National Salvation Front, which ran candidates as a political party. In 1994, the people of Hungary reelected the former Communist Party, renamed the Hungarian Socialist Party.

In Bulgaria, the former Communist Party, which had renamed itself the Socialist Party, won the election. In 1991, the Communist Party won multiparty elections in Albania. But protests by Albanians led the Communists to form a coalition government with other parties. In early 1992, non-Communists took control of the governments in both Albania and Bulgaria.

Communism today

By 1992, Communism was in retreat around the world as a system of government. It was also losing supporters in some non-Communist countries.

In Communist countries. By 1992, Communists held a monopoly on power in only a few countries, including China, Cuba, Laos, North Korea, and Vietnam. But the governments of China and Vietnam were introducing economic reforms.

In non-Communist countries. Hard line Communist parties existed in France, Greece, Portugal and the UK, though they had little or no representation in legislative bodies. The once powerful Italian Communist Party split, and the larger of the two parties that resulted dropped its Marxist policies. In Eastern European countries and former Soviet republics, most Communist parties had reidentified themselves as socialist parties and abandoned Communist principles.

In India, Communists are split into rival parties. Indian Communists hold a significant number of seats in legislative assemblies at both national and state level. The Communist Party of Indonesia was outlawed after its leaders supported an attempt in 1965 to take over the government. In 1992, the Philippine government lifted a 35-year ban on the Communist Party of the Philippines. The South African Communist Party maintains strong links with the African National Congress and exerts a considerable influence over South Africa's politics.

Related articles in World Book include

Bolsheviks
China
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Lenin, V. I.
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Materialism
Mensheviks
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Propaganda

Radio Free Europe/Radio Liberty
Socialism
Stalin, Joseph
Tito, Josip B.
Totalitarianism
Union of Soviet Socialist Republics

Outline

I. Communism in theory

- A. Early communism
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- D. Lenin's contributions

II. Communism in practice

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III. Communism in the Soviet Union

- A. Before 1917
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- A. The Soviet Union under Gorbachev
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VII. Communism today

- A. In Communist countries
- B. In non-Communist countries

Questions

- What did the word *communism* mean originally?
- Who were the Bolsheviks? The Mensheviks?
- What was McCarthyism? What led to it?
- Who planned the Bolshevik Revolution of 1917?
- What basic characteristics did Communist countries share until the 1980s?
- Who wrote the *Communist Manifesto*?
- How does socialism differ from Communism?
- What problems faced the Soviet Union in the 1980s?
- What was the Great Purge?
- How did Lenin's ideas about Communism differ from Marx's thinking?

Communist Manifesto. See Communism (The ideas of Marx); Marx, Karl.

Communist Party. See Communism.

Community, in the social sciences, is a group of people who share similar beliefs and customs and who may live in the same area. The community ranks second only to the family among the oldest and most basic human institutions. Members of a community are linked by emotional bonds. They share a sense of belonging and feel an obligation toward other members of the group.

Since the earliest times, human beings have banded together in groups for companionship, help, and protection. The first communities consisted of small groups of people who inhabited a specific territory. Most of these communities were isolated and self-sufficient.

The history of society includes a decline in the importance of the community. Large numbers of other institutions have taken over its functions. These institutions include schools, corporations, and regional and national governments.

The community has not disappeared, however. Members of modern communities may not live in the same place. Instead, people from different areas may form a community on the basis of ethnic or racial origin, religious or political beliefs, occupation, or friendship.

The term *community* has a different meaning in biology. Biologists define a community as a group of plants and animals living together in the same area and depending on one another. For example, scientists might study a desert or a swamp community.

Community charge. See Poll tax.

Commuter. See Metropolitan area; Suburb.

Commuter train. See Railway.

Como, Lake. See Lake Como.

Comoros is an *archipelago* (group of islands) in the Indian Ocean between the mainland of Africa and the island country of Madagascar. The island group consists of four main islands—Anjouan, Grande Comore, Mayotte, and Moheli—and several smaller ones.

All the islands belonged to France until 1975. Three of the four largest islands declared their independence that year, but Mayotte chose to remain a French possession. The Comoran government considers Mayotte part of the country, but the people of Mayotte have voted to stay under French rule.

The country's official name is the *Federal and Islamic Republic of the Comoros*. The islands, including Mayotte, have a total area of 2,235 square kilometres. Most Comorans live in rural villages. Moroni, on Grande Comore, is the capital and largest city.

Government. A president heads the government of Comoros. The people elect the president to a six-year term. The president appoints a prime minister and a Cabinet. The prime minister and the members of the Cabinet carry out the operations of the government. A legislative body called the Federal Assembly has 38 members. The members are elected by the people to five-year terms. The Comoran Union for Progress is the country's only legal political party. However, there are several opposition groups, most of which are based in France.

People. For Comoros's total population, see the *Facts in brief* table with this article. Most of the people of Comoros have mixed ancestry. They are descendants of Arabs, black Africans, and other groups. About 85 per cent of the Comoran workers have jobs related to farming. But the country has a shortage of good farmland, and it must import much of its food. The chief food is rice. Most of the rice is imported. In addition, the people eat such foods as bananas, cassava, coconuts, fish, maize, and sweet potatoes.

Major problems in the islands include poverty, disease, and hunger. Illness and malnutrition occur frequently, and the nation has a shortage of doctors and hospitals. These problems contribute to a high death rate among the people of Comoros, especially among young children.

Most of the people of Comoros are Muslims. The country's official languages are Comorian and French, though most Comorans do not speak or write French.

Facts in brief about Comoros

Capital: Moroni.

Official languages: Comorian and French.

Total land area: 2,235 km². **Coastline**—391 km. Area figures include Mayotte.

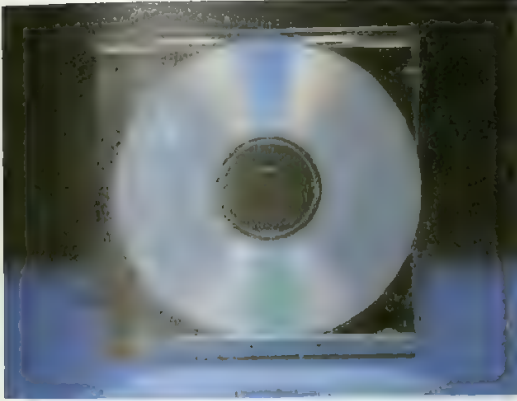
Elevation: *Highest*—Mont Kartala, 2,361 m. *Lowest*—sea level.

Population: *Estimated 1996 population*—676,000; density, 302 people per km²; distribution, 69 per cent rural, 31 per cent urban. *1980 census*—385,890. *Estimated 2001 population*—804,000. Population figures include Mayotte.

Chief products: Bananas, cassava, cloves, coconuts, maize, perfume oil, rice, sweet potatoes, vanilla.

Flag: A green field covers the flag. A crescent moon and four five-pointed stars are in the centre. The green colour and the crescent symbolize Islam. The four stars represent the four islands of the country. Adopted in 1978. See *Flag* (picture: Flags of Africa).

Money: *Currency unit*—franc. One franc=100 centimes.



A compact disc, also called a CD, stores information in coded form. CD's are used chiefly to hold and play recorded music.

the light reflects off the pits, a light-sensitive device turns it into electric signals. These signals correspond to the digital code. An amplifier in the high-fidelity system strengthens the signals and sends them to speakers, which convert them into sound.

Compact discs first became available in 1983 and quickly became popular. They have several advantages over records and tapes. A CD sounds better because it carries almost no background noise or distortion. Compact discs have a long life because lasers cannot wear out or scratch a CD. In addition, their small size makes them easy to handle and store.

In 1988, manufacturers introduced CD-V's (Compact Disc Videos), which carry pictures along with music. A special player for these discs hooks up to a high-fidelity system and TV set.

See also High-fidelity system; Optical disc; Video-disc.

Company is a business enterprise in which people work together for the purpose of manufacturing, buying, or selling goods, or providing a service. In nearly all countries, there is a *companies act*, a law which regulates companies to make sure that they carry out their business in a proper way. Generally, a companies act compels people wanting to start a company to make a formal application. If the application is accepted, the company will be registered at a government office.

Most companies are limited liability companies, sometimes called joint stock companies. *Limited liability* means that the financial responsibility of its owners is limited to the amount of money originally invested. In an *unlimited liability* company, owners are responsible for all company debts, however large.

When a limited liability company is established, its capital (money used to set it up) is divided into shares, which are owned by the members of the company. The members, or shareholders, control the company by attending the annual meeting and electing a board of directors. The directors have responsibility for running the company and making decisions.

Some larger companies are described as *listed* or *quoted*. The shares of these companies may be bought or sold by the general public on a market called a *stock exchange*.

Private limited companies are more numerous than public companies. Their structure makes them much more suitable for small and family businesses. Generally, the number of shareholders is limited by law, and the share owners cannot normally transfer shares to anyone else without the approval of the other owners.

Company, in the armed services. See *Army*.

Comparative anatomy. See *Anatomy*.

Comparative psychology is the study of differences and similarities in the behaviour of animals of different species. Comparative psychologists may analyse a single activity as it occurs in many species. For example, they may examine the raising of young among birds, whales, tigers, and other animals. They also may study the complete behavioural pattern of two or more related species. For instance, they may compare the feeding, mating, and other activities of two rodents.

Some of the principal behavioural patterns of animals that comparative psychologists study include communication, learning, migration, orientation, reproductive behaviour, and social behaviour. *Communication* is the sharing of information among animals. *Learning* concerns the gaining of knowledge or skill. *Migration* is the travel of large groups of animals. *Orientation* consists of the ways that animals position themselves in relation to light, heat, and other forces. *Reproductive behaviour* concerns the mating habits of animals and the ways they care for their young. *Social behaviour* includes such group activities as the flocking of birds or the hunting strategies of wolves.

Comparative psychologists observe animals in their natural environment and in controlled conditions in laboratories and zoos. In both types of surroundings, researchers use methods that enable them to observe behaviour while interfering as little as possible with the creatures' activities. For example, psychologists may attach electronic devices to the animals. The devices send out signals pinpointing their location or relay information on the animal's blood pressure, temperature, and other body functions. In the laboratory, researchers may observe animal behaviour from behind one-way mirrors. In the wild, scientists may watch from inside camouflaged enclosures.



A test of colour recognition, above, requires a monkey to choose between different coloured objects to be given a reward, such as food. Comparative psychologists study the behavioural patterns of animals of different species.

Comparative psychologists may record animal behaviour on paper using code symbols for various types of behaviour. They also film and tape-record certain activities. In addition, they may arrange for an animal to record data itself. For example, many experimenters use a device called a *Skinner box*, where an animal must operate a switch or other mechanism to obtain a reward. The switch also activates a recording device.

Comparative psychologists, like other scientists, employ various statistical methods in their work. They often use computers to analyse large amounts of information. **Comparison**, in grammar, is the inflection of some adjectives and adverbs to express a greater or smaller degree of the quality the word denotes. *Inflection* means changing the form of a word. Possessive, demonstrative, and limiting adjectives cannot be compared.

The three degrees of comparison are the positive, comparative, and superlative. The *positive* is the simple degree, as in, "This book is *heavy*"; "This book is *interesting*." The corresponding adverbs, *heavily* and *interestingly*, are also in the positive.

The *comparative* is used when two objects are being compared, as in, "This book is *heavier* (or *less heavy*) than the other," or, "*more interesting* (or *less interesting*) than the other." The corresponding adverbial forms, such as *more heavily* and *less interestingly*, are also in the comparative degree.

The *superlative* is used to point out the one among three or more objects that has the highest or lowest degree of the quality referred to: "This is the *heaviest* (or *least heavy*) book," or "the *most interesting* (or *least interesting*) book." The corresponding adverbial forms, such as *least heavily* and *most interestingly*, are also in the superlative degree. The superlative is also used in the intensive sense of *very*, without implying comparison, as in "That is *most attractive*."

Regularly compared adjectives add the suffixes *-er* and *-est* to the positive form, as in *proud*, *prouder*, *proudest*. This change is described as *comparison by inflection*. If an adjective is prefixed by the adverbs *more*, *most*, *less*, or *least*, the change is a *periphrastic comparison*, as in *proud*, *more proud*, *most proud*.

Irregularly compared adjectives include some of the most common adjectives in English—words that have come down from Old English, or Anglo-Saxon, forms. The following list contains some irregularly compared adjectives.

Some adjectives and adverbs, such as *perpendicular*, *square*, *eternal*, *unique*, and *perfect* may be absolute in meaning and therefore not subject to comparison. If *unique* means "having no equal," it is not possible for something to be *more unique*? However, phrases like *more perfect*, *rounder*, and *yellowest* are commonly used. More precise phrases would be *more closely perfect*, *more nearly round*, and *most intensely yellow*.

The words *other* and *else* are often used to distinguish the elements that are being compared. For example, if Robert's height is being compared with that of the other boys in his class, a precise phrasing would read: "Robert is taller than *any other boy* (or *anybody else*) in his class," not "Robert is taller than *any boy* (or *anybody*) in his class."

Usage. When two objects are compared, the comparative form is used, not the superlative. "Helen is the

healthier of the twins" is correct. "Helen is the *healthiest* of the twins" is wrong. When comparison is made by inflection, adding an adverb is unnecessary. *Happier* is an adequate comparison. *More happier* is not standard usage. The word *preferable* means "more desirable." *More preferable* is redundant.

See also **Inflection**.

Compass is a device for determining direction. The simplest form of the compass is a magnetized needle mounted on a pivot so that it can turn freely. The needle aligns itself with the earth's magnetic field and points toward magnetic north. Under the needle is a circular *compass card*, on which evenly spaced *points* and *degrees* are marked to indicate direction.

The four *cardinal points* of the compass are north, east, south, and west. The *intercardinal points* are northeast, southeast, southwest, and northwest. Large compasses are marked, clockwise, with the 360 degrees of a circle, in addition to the cardinal and intercardinal points.

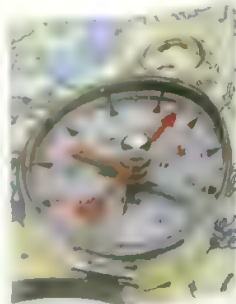
Listed below are the cardinal and intercardinal points and the position on the circle, in terms of degrees, to which each point corresponds.

North—0 or 360 degrees
Northeast—45 degrees
East—90 degrees
Southeast—135 degrees
South—180 degrees
Southwest—225 degrees
West—270 degrees
Northwest—315 degrees

A simple pocket compass helps people find their way when there are no landmarks to guide them. All they need to know is the direction in which they should be travelling. For example, if a person must walk west to reach the nearest town, he or she lines up the needle so that its ends are over the north and south marks on the compass card. The person then travels in the direction 90 degrees to the left of the north end of the needle.

The **mariner's compass** is a magnetic compass used on board a boat or ship. In most cases, it has several magnets fastened on the underside of a compass card. The card rests on a pivot so it can turn freely inside the compass bowl and can always point toward magnetic north. The compass bowl has a transparent cover and is filled with a non-freezable liquid mixture of alcohol and water or glycerin and water. This liquid mixture floats the card and at the same time *damps* (slows) the movement of the card so that it does not constantly swing with the motion of the ship.

Variation. The compass needle points in the general direction of the earth's *north magnetic pole*. The earth's magnetic field has a north pole and a south pole—just as the earth as a whole has poles known as the *true North and South*



A pocket compass has a magnetic needle that points north. A pocket compass helps people find their way when there are no landmarks to guide them.

poles. The true poles are the "top" and "bottom" of the earth, where the earth's spin axis penetrates the earth's surface. The magnetic poles are not located at the true North and South poles. The north magnetic pole is a shifting point on the earth's surface, several hundred kilometres from the true North Pole.

The direction in which the compass needle points is slightly different from the direction of the north magnetic pole at almost all places on earth. The difference arises because the earth's magnetic field is not aligned perfectly in the direction of magnetic north. Rather, the field veers slightly to the east or west at almost all places on earth. The angle between the direction of magnetic north and the true North Pole at any location is called *variation* or *declination*. The variation of a compass is different at different places on the earth. The variation also changes slightly at different times of the year and in different years. Thus, to use a magnetic compass accurately, a person must know the amount of variation at his or her location and what variation correction must be made in reading the compass. This information appears on all mariners' charts and on many maps.

Deviation. If a magnetic compass is placed close to a metal object that contains iron, it will be drawn toward that object. The angle that is formed between magnetic north and the direction the compass points is known as *deviation*.

When a magnetic compass is installed on a ship, it is mounted in *gimbals* (supporting rings that pivot) often in a stand called a *binnacle*. The binnacle has magnetic devices that correct major errors of deviation in the compass. After these corrections have been made, the navigator *swings the ship*. That is, he or she heads the ship in different directions, checking the direction by various landmarks. The navigator notes how many degrees of deviation the compass shows from the exact direction of the ship. For instance, by sighting toward a lighthouse on the east, a navigator can tell that the ship is heading exactly east. However, after the navigator has corrected the compass reading for variation, the compass may indicate the ship is heading two degrees south of east. To head directly east when the ship is out of sight of land, the navigator will steer two degrees south of east on the compass, after correcting for variation. The navigator may also check direction using a *gyrocompass*, which always points toward true north.

History. The Chinese probably first used magnetic compasses as early as the 300s B.C. These compasses were simple pieces of magnetic iron, usually floated on straw or cork in a bowl of water. About the 1300's, the compass card was marked off into 32 points of direction. During the following years, navigators learned more about deviation or variation of compasses in various parts of the world, and came to use magnetic compasses with greater accuracy.

When iron and steel vessels appeared in the late 1800's, it became more difficult to make accurate magnetic compass readings on board a ship. The readings were affected by the metal of the ships. As a result, the gyrocompass was developed. It is not affected by magnetism, and points toward true north.

Large ships today carry both magnetic compasses and gyrocompasses. Ordinary magnetic compasses are not satisfactory in aircraft, and so various gyroscopic

and special magnetic compasses have been developed by scientists for use in aviation. Radio has also been used for compasses. In the 1940's and 1950's, scientists developed special gyroscopes for compass use in the polar regions.

Related articles in World Book include:

Gyrocompass	Navigation
Invention (picture: The magnetic compass)	North Pole
Lodestone	South Pole
Magnetism	Surveyor's compass

Compass plant is a coarse plant that grows in the Midwestern United States. It reaches a height of 3 metres, and is covered with short, rough hairs. The leaves are about 45 centimetres long and cut into several lobes. The lower leaves of the compass plant tend to line up



The yellow flower heads of the compass plant look like sunflowers. This coarse plant grows to a height of 3 metres.

edgewise in a north-south direction. The compass plant is also known as the *pilotweed*.

Scientific classification. The compass plant belongs to the composite family, Compositae (Asteraceae). It is *Silphium laciniatum*.

Competition, in economics. See **Monopoly and competition**.

Composer is a person who writes music. A composer creates a musical composition by arranging the elements of music in a meaningful order. These elements include harmony, melody, rhythm, tone, and *timbre* (tone colour). The term *composer* generally refers to people who write classical music. A composer of popular music is usually called a *songwriter*.

The role of the composer has varied greatly throughout different historical periods. Our earliest knowledge of the lives of composers dates from the 1300's, in the late Middle Ages. During this time, most composers worked for the church or for noble or royal patrons. They often served their employers in other positions, such as poets or secretaries. Much of the music written by composers in the late Middle Ages and early Renais-

sance of the 1400's could be performed interchangeably by voices or instruments.

Later, some composers wrote *chamber music*, which is music for small groups of instruments. Such music was performed privately for the composers' patrons and the patrons' guests.

Public concerts and opera became popular during the baroque period, which lasted from about 1600 until about 1750. During this period, composers began writing for larger groups of performers. Many composers also performed their own music. For example, the German composer Johann Sebastian Bach played his own music for the organ. His job also included writing new music regularly. During the late 1700's and the 1800's, the popularity of public concerts increased. Conductors and *virtuosos* (highly skilled performers) became important in presenting music to large audiences. As a result, the composers' role changed as they provided music for others to interpret in performance.

During the 1900's, the development of electronic music altered the relationship between many composers and the performance of their music. Composers of electronic music use electronic equipment to produce musical sounds. They assemble the sounds on magnetic tape to create a composition. The tape is then played through one or more loudspeakers. Electronic music eliminates the conductor and musicians and gives total control of the performance to the composer. Other modern composers have written *aleatory music*, which provides only an outline of the composition. The performers are allowed great freedom to interpret the work as they wish.

See **Classical music** and its list of *Related articles* on composers. See also **Aleatory music**; **Electronic music**; **Music** (The elements of music; Musical notation).

Composite family, also called *Compositae* or *Asteraceae*, is the largest and the most highly developed family of flowering plants. It consists of more than 20,000 *species* (kinds) of herbs and shrubs. Composite plants have efficient methods of reproduction. They can produce many seeds, and have good methods of scattering them.

Each flower head is a composite of many small flowers. The heads are usually made up of two kinds of flowers, the *ray* and the *disc* flowers. In the sunflower, for example, ray flowers form the yellow outer fringe of the flower head. Disc, or tubular, flowers make up the inner brown disc. The seed coverings of composite plants vary greatly. The seeds of the thistle and dandelion are tipped with feathery hairs and are carried by the wind. Other seeds of composite plants have bristles, scales, or barbs, and are carried on the fur of animals.

Only a few composite plants, including endive, chicory, lettuce, and artichoke, are used as food by human beings. Some, such as calendula, camomile, wormwood, tansy, and amica, are used to make drugs. Chrysanthemums, asters, and dahlias are grown for their beauty. Composite weeds include burdock, dandelion, groundsel, ragweed, and thistle.

Scientific classification. The composite family is in the order *Campanulales*. Some classifications divide it into several families.

Each flowering plant mentioned in this article has a separate article in *World Book*.

Compost is a kind of fertilizer made from partly decayed plant material. Gardeners mix it with the soil to provide *nutrients* (nourishing substances) and to loosen the structure of the soil. It may also be used as a *mulch*—that is, spread on top of the soil to keep moisture in (see *Mulch*).

Compost is made by placing dead plant parts in a heap and allowing them to decay. Grass cuttings and garden-plant clippings, leaves, and coffee grounds are the materials most commonly used, but any plant material is suitable. These materials are packed in layers about 15 centimetres deep. After each layer, a thin layer of manure or soil is usually added to speed decay. Watering the mixture also speeds decay. If a container is used for the compost heap, its walls should allow some air to enter. The compost should decay for five to seven months before it is used.

See also **Gardening** (diagram: A compost heap).

Compound is a substance that contains more than one kind of atom. Every compound has a definite composition that can be described by a chemical formula. For example, water is a compound that contains two kinds of atoms, hydrogen (H) and oxygen (O). Water's chemical formula is written H_2O because there are exactly twice as many hydrogen atoms as oxygen atoms in any sample of water. Other familiar compounds include salt and sugar. These compounds and numerous others occur in nature. Many other compounds are artificially created.

There are more than 100 chemical elements. The atoms in one element are different from those in any other element. The atoms combine in many ways to form millions of compounds. In some cases, atoms of the same elements combine in different proportions to produce a large number of compounds. For example, atoms of carbon and hydrogen can combine to form methane (CH_4), which is the main component in natural gas. These same elements also form propane (C_3H_8).



The composite family includes such flowers as the calendula and dahlia, such weeds as burdock, and lettuce, a vegetable.

which is used as a fuel for torches and camping stoves. There are thousands of other compounds that contain only carbon and hydrogen.

Each compound has its own distinctive properties. Compounds may be solids, liquids, or gases. They also may have a variety of colours. Some compounds will readily undergo a chemical reaction, but others have little tendency to react.

Compounds can be divided into two groups. *Organic compounds* contain carbon atoms. Proteins, fats, carbohydrates, nucleic acids, and many other compounds in living things are organic compounds. All other compounds are called *inorganic compounds*.

Many substances that contain atoms from more than one element are *mixtures*, not compounds. A compound always has the same composition by weight. However, the composition of a mixture is not fixed and varies from sample to sample. For example, chocolate chip ice cream is a mixture. Its composition varies, and some samples contain more chocolate chips than others.

Chemists prepare compounds in several ways. Some compounds are formed by combining elements. The properties of a compound differ from those of the elements from which it was made. For example, the elements sodium and chlorine combine to form the compound sodium chloride, or table salt. Sodium is a soft metal that reacts violently with water and other substances. Chlorine is a yellowish gas that is poisonous. In contrast, sodium chloride is a hard, unreactive, white, crystalline solid.

Compounds can also be made from other compounds. Living things have the ability to add compounds together to form more complex compounds, and to break down compounds into simpler substances. In addition, many compounds break up into simpler compounds or elements when they are heated to high temperatures or exposed to electricity.

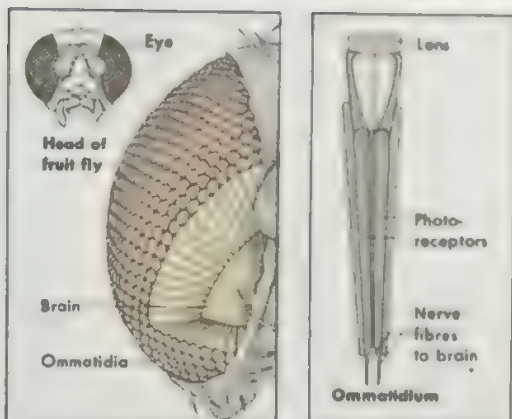
Related articles. See *Chemistry* and its list of *Related articles* on specific chemical compounds. See also:

Acid	Isomers
Atom	Molecule
Base	Radical
Chemical reaction	Salt, Chemical
Element, Chemical	

Compound eye is a type of eye that has many tiny lenses close together. Compound eyes differ from eyes that have only one lens, such as those of fish, birds, and mammals, including human beings. Two large groups of animals have compound eyes—insects and *crustaceans*, which include crabs and lobsters.

The number of lenses in a compound eye varies from fewer than 100 to more than 20,000 among different species of animals. Each lens is the top part of a structure called an *ommatidium*. Beneath the lens, an ommatidium consists of a number of light-sensitive cells called *photoreceptors*, each of which is connected to the brain by a nerve.

The surface of a compound eye is curved. As a result, no two ommatidia face exactly the same direction. Each ommatidium registers an impression of a small part of the animal's surroundings. A single ommatidium does not produce clear images of objects. Instead, the impressions from all the ommatidia form a "mosaic," from which the animal's brain distinguishes patterns of light



The compound eye of a fruit fly, left, is made up of structures called *ommatidia*. Each ommatidium, right, has a lens that lies on top of light-sensitive cells called *photoreceptors*.

and colour. A compound eye has no mechanism for focusing, and so only nearby objects can be seen sharply. However, a compound eye is ideal for detecting motion because even the slightest movement causes a different image to fall on each ommatidium.

Many species of insects have compound eyes that can see ultraviolet light as a distinct colour. The human eye cannot do this. Similarly, certain insects can detect the plane of polarization in polarized light, an ability that the human eye lacks (see *Polarized light*). The ability to detect the plane of polarization helps such insects as ants and bees to navigate by using the sun, because the polarization of sunlight varies according to the sun's position in the sky.

See also *Insect* (Sight; picture); *Ant* (Sense organs).

Compound motor. See *Electric motor* (Kinds of electric motors).

Compressed air. See *Air* (Air compression); *Pneumatic tool*; *Tunnel* (Earth tunnels).

Compression. See *Petrol engine* (High and low compression); *Rotary engine*.

Compressive strength. See *Strength of materials*.

Compressor. See *Air compressor*; *Jet propulsion* (Turbojet); *Pump*; *Turbine* (Gas turbines).

Compton-Burnett, Dame Ivy (1892-1969), an English novelist, ranks among the most accomplished literary stylists of her time. In achieving style, she largely ignored description, plot, and exciting action. Instead, she used highly polished dialogue to reveal the essential nature and inner thoughts of her characters. All her characters speak brilliantly—whether they are adults or children, masters or servants. Many of her books centre around intricate family relationships. They are all set in the late Victorian upper-class atmosphere in which Compton-Burnett was raised. Her novels include *Bullivant and the Lambs* (1948), *Mother and Son* (1955), and *The Mighty and Their Fall* (1962).

Compton-Burnett was born in London. She was made a Dame Commander in the Order of the British Empire in 1967.

Compulsion. See *Neurosis*; *Mental illness* (Anxiety disorders).



Computers come in a wide range of sizes. A mainframe computer system may fill a large room, above. A personal computer, left opposite page, fits on a desk top. Computers are controlled by a microprocessor, a chip that fits through the eye of a needle, right opposite page.

Computer

Computer is a machine that performs calculations and processes information with astonishing speed and precision. A computer can handle vast amounts of information and solve complicated problems. It can take thousands of individual pieces of data and turn them into more usable information—with blinding speed and almost unfailing accuracy. The most powerful computers can perform billions of calculations per second.

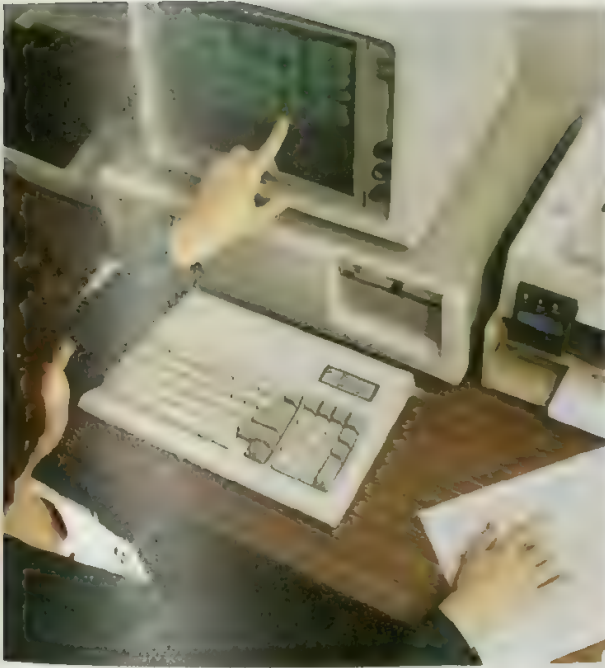
Computers have changed the way people work. They handle many tasks in business, education, manufacturing, transportation, and other fields. Many tedious tasks performed by large numbers of clerical workers are now done by computers. They provide scientists and other researchers with a clearer understanding of nature. They give people who work with words an effective way to create documents. They enable designers and artists to see things that have never been seen before. Computers produce new information so quickly and accurately that they are changing people's views of the world. People can access large electronic databases remotely. For these and other reasons, the computer is one of the most interesting and important machines ever invented.

The most common type of computer, by far, is the *digital computer*. *Digital* means *having to do with numbers*. Digital computers perform tasks by changing one set of numbers into another set. All data—numerals, pictures, sounds, symbols, and words—are translated into numbers inside the computer. Everything a digital com-

puter can do is based on its ability to perform simple procedures on numbers—such as adding, subtracting, or comparing two numbers to see which is larger. Digital computers are so widespread that the word *computer* alone almost always refers to a digital computer. The largest digital computers are parts of computer systems that fill a large room. The smallest digital computers—some so tiny they can pass through the eye of a needle—are found inside wristwatches, pocket calculators, and other devices.

All digital computers have two basic parts—a *memory* and a *processor*. The memory receives data and holds them until needed. The memory is made up of a huge collection of switches. The processor changes data into useful information by converting numbers into other numbers. It reads numbers from the memory, performs basic arithmetic calculations such as addition or subtraction, and puts the answer back into the memory. The processor performs this activity over and over until the desired result is achieved. Both the memory and the processor are *electronic*—that is, they work by sending electrical signals through wires.

The smallest digital computers consist only of the memory and the processor. But larger digital computers are part of systems that also contain *input equipment* and *output equipment*. The operator uses an input device, such as a keyboard, to enter instructions and data into the computer. After processing is complete, an output device translates the processed data into a form



understandable to the user—words or pictures, for example. Typical output devices include printers and visual displays that resemble television screens.

People can think about problems and figure out how to solve them. But computers cannot think. A person must tell the computer in very simple terms exactly what to do with the data it receives. A list of instructions for a computer to follow is called a *program*.

People have used calculating devices since ancient times. The first electronic digital computer, built in 1946, filled a huge room. Since then, rapid improvements in computer technology have led to the development of smaller, more powerful, and less expensive computers.

In addition to digital computers, there are two other general types of computers: *analog computers* and *hybrid computers*. Analog computers work directly with a physical quantity, such as weight or speed, rather than with digits that represent the quantity. Such computers solve problems by measuring a quantity, such as temperature, in terms of another quantity, such as the length of a thin line of liquid in a thermometer. *Hybrid computers* combine the features of analog and digital computers. They have many of the same kinds of parts as an analog computer. But like digital computers, they process data by manipulating numbers. This article focuses on digital computers. For information on analog computers, see *Analog computer*.

The Importance of the computer

Computers are tremendously important in a variety of ways. For example, they simplify many difficult or time-consuming tasks to an extraordinary degree. They provide businesses, governments, individuals, and institutions with an efficient way to manage large amounts of information. Computers also help people to understand

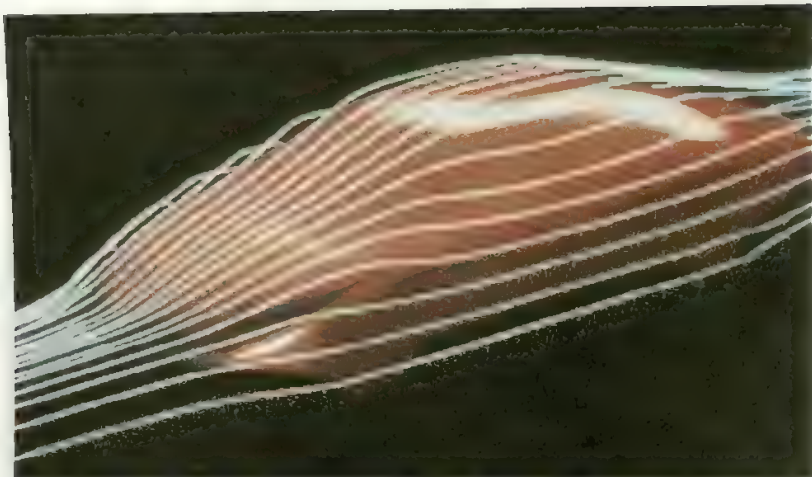
things better by allowing them to make models and test theories.

The value of computers lies in their ability to perform certain basic tasks extremely quickly and accurately. These tasks include (1) solving numerical problems, (2) storing and retrieving information, and (3) creating and displaying documents and pictures.

Solving numerical problems. One of the most important and most difficult jobs performed by computers is the solution of complicated problems involving numbers. Computers can solve such problems amazingly quickly. In many cases, the solutions show how certain things work, behave, or happen.

In engineering and the sciences, the knowledge of how something works is often expressed in the form of an *equation*. An equation is a two-part mathematical sentence in which the parts are equal to each other. Engineers and scientists use equations or groups of equations to show how various things relate to one another. They use the solutions to these equations to predict what will happen if certain elements of a situation or an experiment are changed. Engineers and scientists rely on computers to solve the complicated sets of equations that they use to make predictions.

For example, with the help of a computer, an engineer can predict how well an aeroplane will fly. A large, complex set of equations expresses the relationships between the various parts of an aeroplane and what happens when the aeroplane flies. The engineer enters the numbers for the size and weight of a certain aeroplane's parts. The computer then solves the equations for this particular aeroplane. Based on the solutions, the engineer can predict how well the plane will fly. The engineer then might decide to change the size or weight of one of the aeroplane's parts to change the way it flies.



Computers enable engineers to predict how a machine will work. The photograph on the left shows a computer image of a car being tested for wind resistance.

Thus, the computer helps the engineer *simulate* (imitate) various conditions.

Computers help people develop and test scientific theories. A theory is a proposed explanation for how or why something happens. Theories, like known relationships, are often expressed as equations. Some equations are so complicated or time-consuming to solve that it would be impossible to develop the theory without the help of computers. Computers are particularly useful in developing and evaluating theories about things that are difficult to observe and measure.

For example, an astronomer can use the problem-solving ability of computers to develop theories about how galaxies are formed. First, the astronomer proposes a set of equations about a group of stars. A computer performs the calculations needed to solve the equations. The astronomer can then use the solutions to predict the shape of the galaxy that the stars should form if the theory is correct. To test the theory, the astronomer can observe a real galaxy to see if it has the predicted shape. If the galaxy's shape agrees with the theory, the astronomer becomes more convinced that the theory is correct. If the galaxy's shape does not agree with the theory, the theory is wrong. The equations must be changed, and new calculations must be performed.

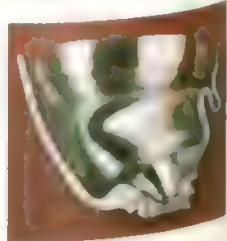
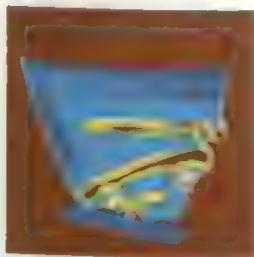
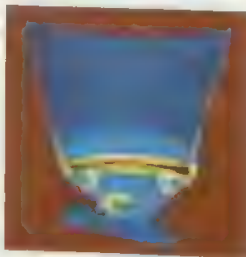
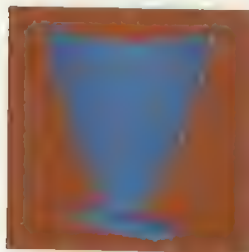
In *economics and finance*, computers solve equations to make predictions about money. Many of the equations that economists and business people use to make long-range predictions are extremely complicated.

But some of the most widely used of all computer programs rely on fairly simple equations. Such programs help people and businesses work out their taxes, create budgets, and calculate the value of their investments.

Storing and retrieving information. People use computers to store unbelievably large quantities of information. Information stored in a computer is sometimes called a *database*. Databases can be enormous—for example, a country's entire census might be contained in a single database. A computer can search a huge database quickly to find a specific piece of information. In addition, the information can be changed easily and quickly—often in less than a second.

The efficiency with which computers store and retrieve information makes them valuable in a wide range of professions. For example, scientists use computers to store and quickly find results of experiments. Libraries use computer catalogues to hold information about their collections. Hospitals use computers to maintain records about their patients. Governments store election returns and census information on computers.

All kinds of businesses rely on computers to store large quantities of information about their employees, customers, and products. Computers also allow markets for stocks, bonds, currency, and other investments to keep track of current prices around the world. Banks maintain many kinds of records on computers, such as account balances and credit card information. Anyone who uses an *automatic teller machine* (ATM) is using a



A computer simulation can accurately represent an operation, situation, or system. The first three photographs above show computer-generated images of a bomb's nose cone striking a steel plate. The fourth photograph—which shows an actual nose cone after a test—reveals the great accuracy of the computer simulation.

computer terminal. When an identification card and number are entered, the ATM can provide account information, dispense cash, and transfer funds between accounts.

Creating and displaying documents and pictures.

Computers can store a huge number of words in a way that makes it easy to manipulate them. For this reason, *word processing* is one of the most important and widespread uses of computers. A *word-processing program* allows people to type words into a computer to write articles, books, letters, reports, and other kinds of documents.

Word-processing programs make it easy for people to change text that has been typed into a computer. For example, they can quickly correct typing or spelling errors. Words, sentences, and entire sections of a document can be added, removed, or rearranged. If a computer is connected to a printer, the document may be printed onto paper at any time. Business people, journalists, lawyers, scientists, secretaries, and students are among those who benefit from word-processing programs.

Computers are also important in the publishing industry. For example, most books, magazines, and newspapers are typeset by computers. In addition, a process known as *desktop publishing* enables people to design and produce newsletters and other documents on personal computers. Documents that have been created in this manner look almost as if they have been professionally typeset.

Computer graphics—the use of computers to make pictures—make up one of the most fascinating and fastest-growing areas of computer use. Computers can produce pictures that look almost like photographs. First, the computer solves equations that predict how an object should look. It then uses these predictions to display a picture on a computer terminal screen or to print a picture on paper.

Computer programs that perform *computer-aided design* (CAD) are important in many fields, particularly engineering and architecture. CAD programs create pictures or diagrams of a new object. They then solve equations to predict how the object will work. Engineers and architects use CAD programs to design aeroplanes, bridges, buildings, cars, electronic machinery, and many other machines and structures.

Computers also can produce pictures by converting information into pictorial form. The pictures can serve a variety of purposes. For example, computers enable business people, economists, and scientists to plot graphs from lists of numbers.

In a technique called *computerized tomography*, or the *CT scan*, a computer uses X-ray data to construct an image of a body part on a screen. Doctors use these images to diagnose diseases and disorders (see *Computerized tomography*). Sophisticated radar systems use computers to produce detailed pictures, often for military use.

Computer graphics also are used to create electronic video games. Terminal monitors or TV screens can display game boards and moving pictures. The player may use a keyboard or some other device, such as a *mouse* or a *joystick*, to play computer games.

Computer designers are experimenting with using

computer graphics to create *virtual reality*—an artificial world in which the computer user can seemingly move about and handle objects. One virtual reality system has a headset with two tiny display screens, one screen for each eye. Images on the screens produce a three-dimensional view. Sensing devices contained in a special glove tell the computer when the user moves the fingers or hand. The computer then changes the images to create the illusion of, for example, opening a door.

The images do not have nearly the detail of what is seen in the actual world. In addition, there is a delay between hand movements and the corresponding changes in the images. However, virtual reality has a variety of applications. These applications range from simple game sets to sophisticated equipment used to control robots.

Other uses. Many complex machines need frequent adjustments to work efficiently. Small computers can be installed inside these machines and programmed to make these adjustments. In modern cars, such *embedded* (enclosed) computers control certain aspects of operation, such as the mixture of fuel and air entering the engine. Today's commercial airliners and military planes carry computers that help control the aircraft. Embedded computers also control the movements of industrial robots and are used to guide modern weapons systems,



Computer-aided design programs are important in many fields. An engineer, *top*, uses a light pen to modify the design of an aeroplane. A fashion designer, *above*, can consider her design in various colours and patterns on a computer screen.

such as missiles and field artillery, to their targets.

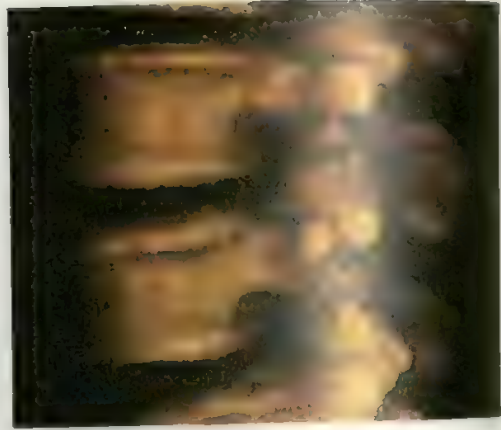
Computers can help solve many complicated problems that do not involve numerical equations. Doctors, for example, investigate illnesses, decide on diagnoses, and prescribe treatments. They solve such problems by applying their knowledge and experience—not by solving equations. A branch of computer science called *artificial intelligence* uses programs that help solve problems by applying human knowledge and experience. Artificial intelligence systems called *expert systems* enable computers programmed with vast amounts of data to “think” about numerous possibilities—such as diseases that certain symptoms could indicate—and make a decision or diagnosis.

Computers also can be used to communicate information over long distances. They can send information to each other over telephone lines. As a result, computers keep banks, newspapers, and other institutions supplied with up-to-the-minute information. A *computer network* consists of many computers in separate rooms, buildings, cities, or countries, all connected together. Computer networks allow people to communicate by using *electronic mail*—a document typed into one computer and “delivered” to another. Such documents generally travel in only a few minutes, even if they are being sent over a long distance.

Computers also are used in teaching. Programs that perform *computer-aided instruction* (CAI) are designed to help students at all levels, from elementary school to the university level. The student sits at a computer terminal. The terminal’s screen displays a question for the student to answer. If the answer is wrong or incomplete, the computer may ask the student to try again. It then may supply the correct answer and an explanation. CAI is also used in some adult education programs and as part of the employee-training programs of some corporations.

Basic principles of computers

A computer receives individual pieces of data, changes the data into more useful information, and then tells the operator what the information is. For example, a person who wants to find the sum of four numbers enters them into the computer. In only a fraction of a second, signals that represent these numbers are changed



Computers use X-ray data to generate three-dimensional images of body parts such as the human spine, above. The image help doctors identify disorders without performing surgery.

into signals that represent the sum. The computer then displays the sum for the user.

How a computer operates. People use input devices to enter data into computers. One of the most common input devices is the *computer terminal*, which looks like a typewriter keyboard combined with a television screen. Data that are typed on the keyboard appear on the screen. At the same time, the data go to the memory. The memory also stores a program—the step-by-step series of instructions for the computer to follow. The processor manipulates the data according to the program.

The processed information is sent to an output device, which presents it to the computer user. In many cases, the computer terminal that served as the input device also acts as the output device, and its screen displays the results. Printers are another important kind of output device. *File storage devices* are used to save information and programs for future use.

All data handled by computers, including words, enter the processor in the form of digits. Computers commonly use the digits of the *binary numeration system* (see Numeration systems [The binary system]). Un-



Computers help meteorologists forecast the weather by solving equations that describe the behaviour of the atmosphere.



Computer games entertain children and adults. Many games display detailed moving pictures on monitors or TV screens.



Schools use computers as a teaching aid. An elementary school teacher and his students work at a computer, above.

Like the familiar decimal system, which uses 10 digits, the binary system uses only two digits: 0 and 1. These digits are called *bits*. Different combinations of bits represent letters, symbols, and decimal numerals. Each such combination of bits is called a *byte*. For example, according to one standard code, the binary representation for the letter A is 100 0001, while the binary representation for the letter Z is 101 1010. Each symbol and decimal numeral also is represented by a specific combination of 0's and 1's.

Each of a computer's thousands of tiny electronic circuits operates much like an ordinary light switch. When a circuit is off, it corresponds to the binary digit 0. When a circuit is on, it corresponds to the digit 1. Binary digits, like decimal numbers, can be added, subtracted, multiplied, and divided. Thus, a computer can perform all the basic arithmetic operations.

Computer hardware and software. The physical equipment that makes up a computer system is called *hardware*. Hardware includes input and output devices, file storage devices, the memory, and the processor. The input and output devices and the file storage devices are also known as *peripheral equipment*.

Computer *software* consists of the programs that a computer uses to perform a task. People can either create or purchase software. Computers have vast and varied capabilities because of the many different kinds of available software.

Kinds of computers

Computers vary widely in size, speed, and ability. The size of a computer partly determines the kinds and number of jobs it can do. But even a small computer can perform complicated tasks. For example, a modern desktop computer has more computing power than the huge, room-filling computers of the early 1960's.

The *microprocessor*—an electronic device consisting of thousands of transistors and related circuitry on a sili-

con chip—plays an important role in almost all modern computers. A single microprocessor has the computing power of a larger computer but generally costs far less. The small size and relatively low cost of microprocessors have made them valuable as components in computer systems.

Digital computers may be grouped into three categories: (1) embedded computers, (2) personal computers and workstations, and (3) mainframes. The borders between these categories change constantly as smaller, more powerful computers are developed.

Embedded computers control the operation of various types of machinery. Virtually all embedded computers are microprocessors. Such machines as cars, digital wristwatches, telephones, and videotape recorders contain embedded computers.

Personal computers and workstations are computers used by one person at a time. Such a computer usually fits on a desk top, and some personal computers can be held on the lap or in the hands. People commonly use personal computers for such activities as word processing, storing and updating information, performing simple calculations, and playing computer games. These computers also are valuable to business people, who use them to manage information about their inventories, sales figures, customers, and employees.

Personal computers contain one or more microprocessors. By modern standards of computer speed and

Computer terms

Binary code is used by computers to represent information. It consists of the 0's and 1's of the binary numeration system.

Bit, an abbreviation of the term *binary digit*, may be either the digit 0 or 1.

Byte is a group of bits that act as a single unit of information such as a letter or numeral.

Database is an organized collection of information stored on a magnetic disk or other direct-access storage device.

File storage device is any device used to save information until it is needed again.

Hardware refers to the physical parts of a computer system.

Input is any information that a user enters into a computer.

Mainframe is a large, powerful computer that many people can use at once. It can store large amounts of information.

Memory is the part of a computer that stores information.

Microprocessor is a miniature electronic device consisting of thousands of transistors and related circuitry on a silicon chip.

The device holds the processor and some memory.

Modem is a device that allows computer users to communicate with one another over telephone lines.

Network is a system consisting of two or more computers connected by high-speed communication lines.

Operating system is a type of software that controls the operation of a computer system.

Output is any result provided by a computer.

Peripheral equipment consists of input devices, output devices, and file storage devices.

Personal computer is a desktop or handheld computer designed for general-purpose use.

Program is a set of instructions to be carried out by a computer, written in a computer language.

Simulation is the representation or imitation of a situation or system on a computer, usually with a mathematical model.

The purpose is to predict and analyze what is likely to occur under various conditions.

Software refers to the programs used by a computer to perform desired tasks.

capacity, personal computers execute programs slowly and have limited memory and file storage capacity.

Workstations are more powerful than personal computers, and better suited to solving difficult engineering, graphics, or scientific problems. Workstations are generally connected to form computer networks. These networks allow operators to exchange information very rapidly. They also enable printers and file storage devices to be shared by many workstations. One important type of computer network, the *local area network* (LAN), connects workstations located within the same building or in neighbouring buildings. A *wide area network* (WAN) links workstations over large areas.

Mainframes are fast computers with large memories and file storage systems. These powerful computers solve very complicated problems and manage huge quantities of information. Most mainframes are housed in several large cabinets. Some mainframes do a single job, such as copying and storing the information generated by a laboratory experiment. Others perform many different tasks. *Minicomputers* and *superminis* have many of the capabilities of mainframes, but they are smaller and less expensive.

On a large mainframe, hundreds of people may be *logged on* (running programs) at one time. The use of a single powerful computer by many users at once is called *time-sharing*. The mainframe appears to run many programs at the same time. However, the computer actually switches rapidly from hurrying to program, doing a bit of work on one and then hurrying on to work on another.

The fastest mainframes are called *supercomputers*. Supercomputers solve numerical problems as quickly as possible based on existing technology. They are used to model weather systems, to design cars and aircraft, and in many other ways. But supercomputers are rare, because they are extremely expensive. Individual supercomputer users—mostly scientists and engineers at large scientific installations—sometimes run programs by means of long-distance computer networks.

In recent years, mainframes known as *parallel computers* have provided great increases in speed over other computers. Most computers have a single processor. But a parallel computer has many processors that all operate at once. Each processor can work on a separate piece of a program. As a result, the program can be run much more quickly than on a computer with only one processor. The fastest supercomputers in the world are parallel computers. But parallel computers may even serve as especially fast workstations.

How a computer works

Computers can perform many different activities because they can store huge lists of numbers and do arithmetic very rapidly. All computers work essentially the same way. A computer *encodes* (translates) numbers, words, pictures, sounds, and other forms of data into the 0's and 1's of the binary numeration system. The computer's processor manipulates the binary numbers according to specified instructions. All changes of the data are accomplished by performing arithmetical calculations on these binary numbers. Thus, the binary numbers that represent the data are changed into binary numbers that represent the desired information. The re-

sults are *decoded* (translated back) from binary numbers into decimal numbers, words, pictures, or some other form.

The operation of a computer can be broken down into three steps. They are (1) entering and encoding data and instructions, (2) processing data, and (3) decoding the results and producing output. The storing of information occurs during all three steps of the computing process.

Entering and encoding data and instructions is performed using input equipment. This section explains how the computer encodes data entered through a terminal. It also describes a number of other input devices.

Terminals enable computer users to type *characters* (letters and numerals) directly into the computer. A terminal includes a keyboard unit and a *monitor*. The monitor usually consists of a *cathode-ray tube* (CRT). A CRT is a vacuum tube with a screen like that of a television (see *Vacuum tube*). The CRT display makes it possible for the user to check the data being entered into the computer and to make corrections if necessary.

As each character is typed, the circuitry inside the terminal puts the character's binary code into a temporary storage location called a *buffer*. As soon as a code appears in the buffer, the processor executes an instruction that moves it from the buffer to the computer's memory. The monitor also has a buffer. Whenever the processor sends a code into this buffer, the corresponding character appears on the screen.

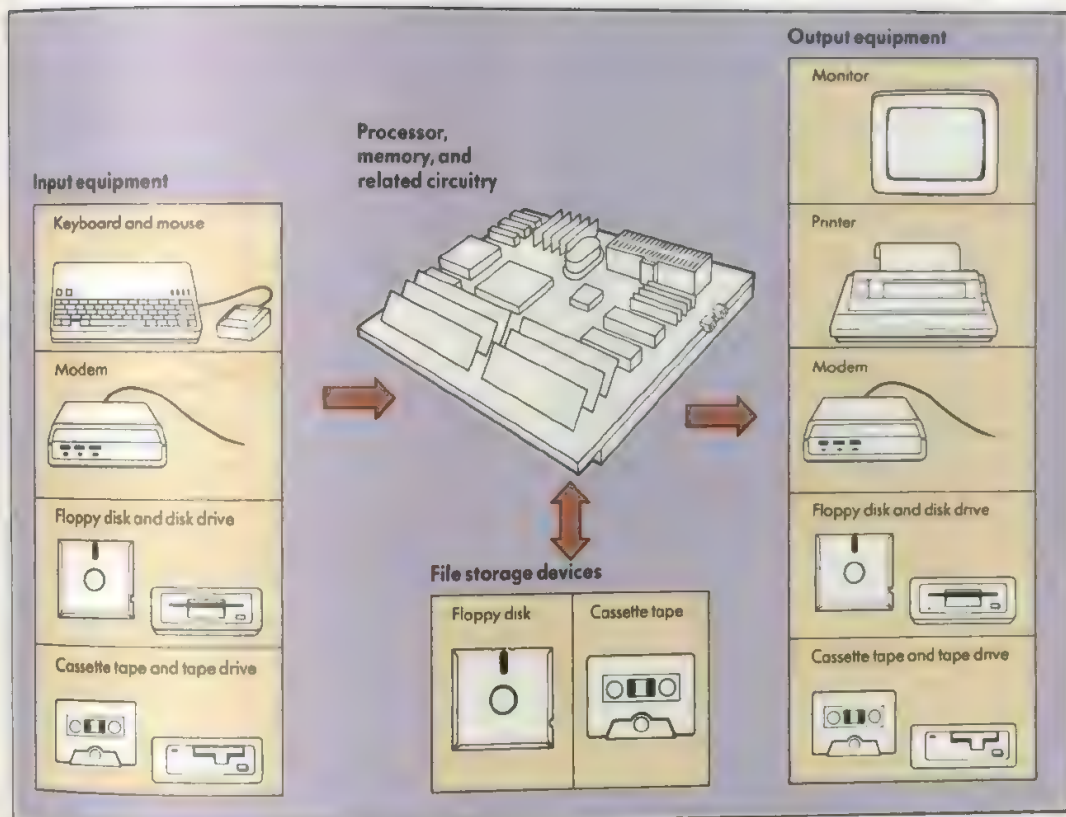
Other input devices are also used with monitors. For example, some terminals enable users to communicate with the computer by drawing pictures or diagrams directly on the screen with a light pen. Such units encode drawings directly from the monitor. A device called a *mouse* can be used to give commands to a computer. When this handheld box is moved on a flat surface, it causes a pointer to point at a specific instruction or piece of data displayed on a monitor. Clicking a button on the mouse causes the instruction to be carried out or the data to be moved or changed.

Modems are devices that allow computers to communicate with other computers by using telephone lines. A modem translates binary codes into tones. At the other end of the line, another modem translates these tones back into digital data.

Disk drives and tape drives perform many functions in the operation of the computer. One of these functions is providing input in binary form. A disk drive is a machine that, among other things, reads 0's and 1's that are magnetically encoded onto disks. This information then goes to the buffer and the memory. A disk system provides quick and direct access to specific information located anywhere on a disk. Flexible magnetic disks called *floppy disks* or *diskettes* are widely used to provide input to personal computers. *Hard disks* are used with larger computer systems, as well as with some personal computers.

Tape drives and magnetic tapes work in much the same way. However, a tape must be unwound or rewound to the location that contains the desired information. As a result, it takes longer to read information from a tape than from a disk.

Optical scanners also read data and instructions. Some scanners optically sense bar codes and other



How a computer works

Computer systems come in a wide range of sizes and contain varying types of equipment. Nevertheless, all digital computers work essentially the same way. The diagram above illustrates the flow of information through a personal computer system. A human operator uses *input equipment* to provide data and instructions to the computer. The *processor* then performs calculations on the data, while the *memory* stores information during processing. The results then are sent to the *output equipment*, which presents them to the user. *File storage devices* enable information to be saved for future use.

marks printed on identification and library cards, grocery items, or documents. They then change these codes into electrical signals. Other scanners read information from *compact discs* or *optical disks*. Such disks contain digitally encoded information that can be read by a laser beam.

Other input devices include a joystick for moving figures about on a screen and a *graphic tablet* consisting of a pad and a special pen for producing illustrations. Such devices are used with some personal computers. *Voice activators* enable computers to understand spoken words. Some mainframes obtain input by means of *card readers*, which take information from punched cards. The pattern of punches represents letters, numbers, and other symbols. Card readers once were popular, but today they are used less frequently.

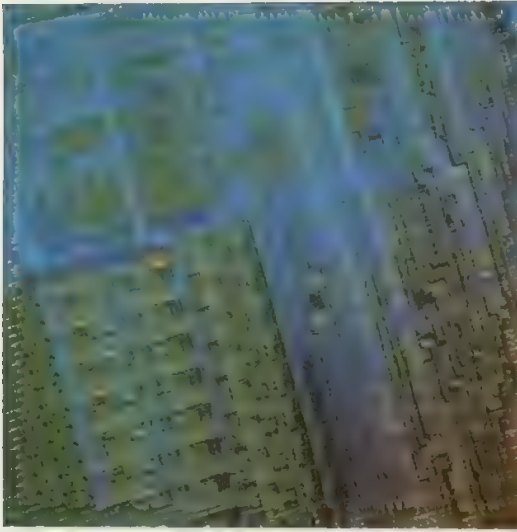
Processing data. The processor, also called the *central processing unit* or *CPU*, is the heart of the computer. It manipulates the binary numbers that represent input according to a program and converts them into binary numbers that represent the desired result.

Since the development of the *integrated circuit* in the 1960s, the processor in many computers is contained on a single *microprocessor*—a silicon chip no larger

than a fingernail (see *Integrated circuit*). All the devices and wires that make up the processor are packed onto the surface of the chip. Silicon is one of a group of materials called *semiconductors* (see *Semiconductor*). The circuitry on the chip contains many tiny devices called *transistors*. A transistor can either stop electric current or allow it to flow (see *Transistor*). The processor of a computer consists of two parts: (1) the *control unit* and (2) the *digital logic unit*.

The control unit directs and coordinates the operations of the entire computer according to instructions stored in the memory. The control unit must select the instructions in proper order because their sequence determines each step in the operations. Each set of instructions is expressed through a *binary operation code* that specifies exactly what must be done to complete a job. The operation code also provides information that tells where data for the processing operation are stored in the memory. The control unit interprets the instructions and relays commands to the logic unit. It also regulates the flow of data between the memory and the logic unit and routes processed information to output or file storage devices.

The digital logic unit, sometimes known as the



An integrated circuit contains all of the tiny devices that make up the processor on a single, tiny chip. This photograph, taken through a microscope, shows a portion of such a chip.

arithmetic/logic unit or *ALU*, manipulates data received from the memory. It carries out all the functions and logic processes required to solve a problem. Computers use logic to perform arithmetical calculations—addition, subtraction, multiplication, and division.

In the digital logic unit, electronic circuits called *registers* temporarily store data from the memory. The data consist of electrical signals that represent binary digits. An electrical signal that has a low voltage level represents 0, and a signal that has a high voltage level represents 1.

To carry out an arithmetical calculation, the electrical signal for each input travels on a wire to another circuit. The answer comes out on a wire from the other end of the circuit. There are a number of basic circuits. Three such circuits are the *AND-gate*, the *OR-gate*, and the *NOT-gate* or *inverter*. The basic circuits are combined in different ways to perform arithmetic and logic operations with electrical signals that represent binary digits. For example, one combination of logic circuits performs addition. Another combination compares two numbers and then acts on the result of the comparison.

After an operation has been completed, the result may be sent to the memory for storage until it is needed for another operation. In many cases, the result is sent to an output device or a file storage device.

Decoding the results and producing output. People use *output equipment* to get information from computers. Output equipment translates the electrical signals that represent binary numbers into a form that the user can understand. Often, it also serves as input equipment. There are many types of output devices, such as terminals, printers, modems, and disk and tape drives.

Terminals, in addition to serving as input equipment, display output on the monitor. As information travels from the processor to the terminal, it moves through the buffer that was used in the input function. On a terminal,

a user can receive data in the form of words, numbers, graphs, or pictures.

Printers produce output on paper. Like terminals, printers have buffers. To print a character, the processor puts the binary code for that character into the printer's buffer. The printer prints the character that corresponds to the code. Some printers operate much like typewriters. Others use heat, special chemicals, lasers, or combinations of these methods to place characters on paper.

Modems, which translate sounds into binary numbers during the input function, can also provide output by translating binary numbers into sounds. As a result, they enable users to receive information from distant computers.

Disk drives and tape drives also serve as both input and output equipment. Magnetic disks and tapes receive output in binary form. The drives interpret binary information from disks and tapes and present it to the user, often on a monitor. Output data presented on disks and tapes can easily be put back in the computer when needed.

Other output devices include *plotters*, *key punch machines*, and *audio devices*. Plotters use pens to create drawings, diagrams, and graphs on paper or clear plastic. Key punch machines record data by punching holes in cards or paper tape. Audio devices produce spoken words through a type of telephone or loudspeaker. Such devices are becoming increasingly important.

Storing information. Computers can store information in two types of locations during the computing process—the memory and file storage devices. Memory, which is built into the computer, holds instructions and data during processing. File storage devices provide long-term storage of large amounts of information.

Memory, also called the *internal memory* or *main memory*, stores information and programs inside the computer. The memory receives data and instructions from an input device or a file storage device. It also receives information from the processor. The memory stores only the information that is currently needed by the processor. After the processor has finished with it, the information is transferred to file storage devices for permanent storage or sent directly to an output device for immediate use.

The devices and wires that make up the memory can be built from integrated circuits that fit onto one or more chips. The circuits, wires, and transistors form many *memory cells* capable of storing binary digits. These cells are arranged into groups. Each group is assigned an *address*—a number that makes it possible to locate specific pieces of information quickly.

File storage devices, also called *auxiliary storage units*, can store huge amounts of information for long periods of time. Such units are slower than the memory that is built into the computer. But they can hold much more information and they are less expensive. For this reason, file storage devices are commonly used to store large quantities of data, programs, and processed information.

The most important file storage devices are magnetic disks and magnetic tapes. Disks and tapes are operated by disk drives and tape drives, which also serve as input and output equipment. These units encode data onto the surfaces of disks and tapes by turning the electrical

BASIC language

```

10 SUM = 0
20 READ LENGTH
30 COUNTER = LENGTH
40 READ NEXT
50 SUM = SUM + NEXT
60 IF COUNTER = 1 GOTO 90
70 COUNTER = COUNTER - 1
80 GOTO 40
90 AVG = SUM/LENGTH
100 PRINT AVG
110 DATA 7, 35, 9000, 876, 29, 87, 90, 153
120 END

```

APL language

```

NUMBERS ← (35, 9000, 876, 29, 87, 90, 153)
LENGTH ← 7
SUM ← +/NUMBERS
ANSWER ← SUM ÷ LENGTH

```

Machine language

1. Load the first number on the list into a box called R1.
2. Load the length of the list into a box called R2.
3. If the number in R2 is 1, go to step 7.
4. Add the next number on the list to the number in box R1.
5. Subtract 1 from the number in box R2.
6. Go back to step 3.
7. Divide the number in box R1 by the length of the list.
8. The answer is now in box R1.

Programming languages enable people to write instructions that a computer can translate and execute. The languages allow the programmer to concentrate on the basic ideas of an operation, instead of on the details of what the machine must do. The BASIC and APL programs shown above both contain instructions for finding the average of a list of numbers. The steps in machine language show how a computer interprets and executes this type of program in any language.

signals that represent the 0's and 1's of binary code into magnetism. Every 0 is represented on the disk or tape by a little magnet pointing in a certain direction, and every 1 by a magnet pointing in the opposite direction. To read information from a disk or tape, the drive unit translates the magnetic signals into electrical signals and sends them to the memory. Magnetic disks are said to be *random-access* devices because any part of the information on them can be inspected or replaced with ease.

Some other types of file storage devices contain *read-only memory* (ROM) information that the computer cannot change. ROM units may consist of a compact disc, a cartridge, or a silicon chip. They are used to store large databases and programs for computer games.

Programming a computer

Programming involves the preparation and writing of detailed instructions for a computer. These instructions tell the computer exactly what data to use and what sequence of operations to perform with the data. Without programs, a computer could not solve problems or deliver any other desired result.

Some people prepare their own computer programs. But in many cases, computer scientists and other computer specialists called *programmers* write instructions for computers. They use *programming languages* that consist of letters, words, and symbols, as well as rules for combining those elements.

A computer cannot work directly with a program written in a programming language. The instructions must be translated into a *machine language* composed of binary digits. These digits represent operation codes, memory addresses, and various symbols, such as plus

and minus signs. Machine language is also known as *low-level language*.

Special programs called *compilers* and *assemblers* translate programming languages into machine language. Another special type of program called an *operating system* contains instructions for the operation of a computer. It controls the input and output devices, and it reads and responds to user commands. It also places programs and data into the memory and makes sure that the processor executes the right programs. Thus, the operating system combines the many separate parts of a computer into a single useful system.

Compilers, assemblers, and operating systems may be viewed as "smart (intelligent) programs" because they enable a computer to understand complicated instructions. The user communicates with the smart program, and the smart program communicates with the computer. A computer combined with a smart program acts like a different, smarter computer. This combination is called a *virtual machine*.

Preparing a program begins with a complete description of the job that the computer is to perform. This job description is obtained from the person for whom the program is being prepared, such as a business manager or an engineer. It explains what input data are needed, what computing must be done, and what the output should be. Computer programmers use the description to prepare diagrams and other pictorial aids that represent the steps needed to complete the task. The programmers may produce a diagram called a *systems flow chart* that shows how all the major parts of the job fit together systematically.

After a computer program is written, it is tested on the computer for mistakes. Computer experts refer to

mistakes in programs as "bugs" and the testing of programs as "debugging."

A program generally is entered into a computer in what is known as an *interactive environment*. In such an environment, the programmer enters part of the program on a computer terminal. The computer's operating system responds immediately, telling the programmer how the computer will interpret each instruction. The programmer then can analyse each response. Programs that result from this interaction between the programmer and the computer generally are stored on some type of file storage device until needed.

Using programming languages. Computers appear to work directly with programming languages. But the smart program, not the computer, actually understands these languages. The smart program translates a program into machine language. It then enters the translated version into the computer's memory. The processor reads and executes each translated instruction.

There are many different *high-level* programming languages. Some of them closely resemble the language of mathematics. Others enable programmers to use symbols and various everyday expressions, such as "READ," "PRINT," and "STOP." All high-level languages are designed to let the programmer concentrate on the basic ideas of a task rather than on the details.

The language that a programmer uses depends largely on the job to be done. If a task involves processing business data, the programmer would most likely use COBOL (*CO*mmon *B*usiness *O*riented *L*anguage). However, programming a computer to solve complicated scientific problems might require the use of a mathematically oriented language, such as FORTRAN (*FOR*mula *TRAN*slation).

Some high-level languages can be used for business, technical, or scientific programming. Such languages include APL (*A* *P*rogramming *L*anguage); C; and LISP (*L*IST *P*rocessor).

Another commonly used programming language is

BASIC (*B*eginner's *A*ll-purpose *S*ymbolic *I*nstruction *C*ode). BASIC is well suited for writing relatively simple programs for personal computers. Many primary schools and secondary schools that offer a course in programming teach BASIC because it is easy to learn and to use. Pascal, named after the French mathematician and scientist Blaise Pascal, also is taught in a large number of schools.

Some computer programs may be written in an *assembly language*. This kind of language is harder to use than a high-level language. The programmer must state each instruction very precisely, with much more detail than is needed when using a high-level language.

The computer industry

The manufacture, development, sales, and servicing of computer hardware and software make up one of the largest and most important industries in the world. Governments, institutions, and virtually all industries rely upon computers. By the year 2000, the computer industry is expected to be the second largest industry in the world in terms of annual revenue. Only agriculture will be larger.

The first commercial digital computers were manufactured in the 1950's. Throughout the 1950's, as the importance of computers increased, people's acceptance of them increased as well. More than 10,000 computers were in operation by 1961. Ten years later, the number of computers exceeded 100,000. By 1990, there were about 100 million data-processing computers—that is, computers that require input and output equipment—in operation worldwide.

The United States has the largest computer industry in the world, employing more than 1 million people. It also has more computers than any other country—more than 50 million, or about half the world's computers. Japan ranks second with more than 9 million computers, about 11 per cent of the world total. European countries account for nearly 25 per cent of all computers.



Computer firms manufacture hardware, software, and supplies. In this picture, quality control workers check computers on an assembly line.

The economic growth of the computer industry has matched the increase in the number of computers. The United States produced about \$1 billion worth of computers in 1958. Ten years later, the figure had reached \$4.8 billion. By 1978, United States manufacturers produced more than \$16.6 billion worth of computer equipment each year.

In the late 1970's, the computer industry's rate of growth increased dramatically. Advances in both computer technology and manufacturing technology enabled the United States to sell computers worth more than \$30 billion in 1981. By 1990, the U.S. computer industry's annual revenues had topped \$100 billion, and they continued to grow.

Manufacturing. From a few dozen companies in the early 1960's, the computer industry has grown to more than 10,000 firms around the world. These companies manufacture computers and such peripheral equipment as modems and printers. They also develop and publish software and provide various computer supplies, such as magnetic disks.

Some companies produce entire computer systems, ranging from personal computers to supercomputers. A large number of companies manufacture computer components, including processors. Some companies produce input and output equipment, such as terminals and printers. Other important products of the computer industry include equipment that increases a computer's abilities to provide visual and audio output, and the network boards and cables used to create computer networks.

The largest computer manufacturer in the United States—and the world—is International Business Machines Corporation (IBM). By the late 1980's, IBM's annual sales had topped \$50 billion. Digital Equipment Corporation (DEC) ranks second in the United States, with more than \$9 billion in sales in 1988. Unisys is the third largest U.S. manufacturer, with more than \$7 billion in annual sales in the late 1980's. Other leading U.S. computer companies include Apple, Compaq, Cray, Tandy, and Zenith.

The largest computer manufacturer outside the United States is Japan's Fujitsu, followed closely by NEC Corporation, also of Japan. Each company had sales of more than \$9 billion in 1988. The leading computer companies in Europe include Groupe Bull of France, Italy's Olivetti, and Siemens AG of Germany.

Research and development. The constant increase in computer power is a major reason for the computer industry's success. Such increases in power result from computer science research and development, which take place at businesses and universities throughout the world.

One area of great interest to computer researchers and manufacturers is memory speed and capacity. As software becomes more complex, it requires more computer memory in order to operate properly. At the same time, sophisticated software can manipulate increasingly large amounts of data, which occupy more space in the computer's memory.

The storage of information files is another important area of study. Researchers work to develop increasingly compact ways to store data, such as on magnetic disks, compact discs, or other devices.

Artificial intelligence is an exciting area of software research. Experts in this field design computer systems to perform tasks that appear to require intelligence, such as reasoning and learning. In this manner, artificial intelligence experts hope to increase the ability of computers to respond to problems in a "human" manner. See **Artificial intelligence**.

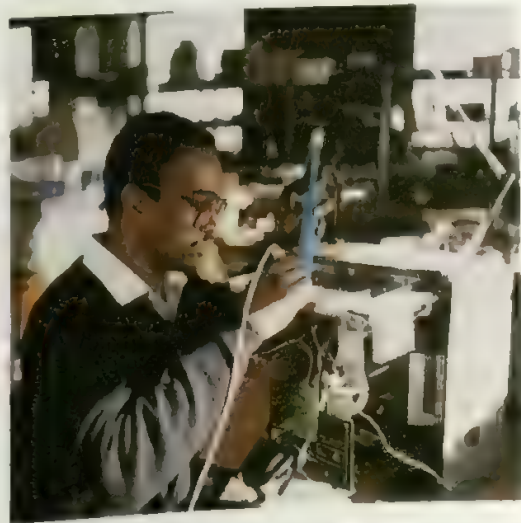
Sales. Computers are sold in a variety of ways. Large manufacturers of computers have teams of sales professionals. These teams call on corporations and institutions, analyse their needs, and provide the appropriate combination of hardware and software. Some companies purchase computer systems and components from a variety of sources. They assemble the components and then sell the finished products to computer users.

Retail outlets play an increasingly important role in the sale of personal computers. Chains of computer stores sell many personal computers. Some general merchandise stores also sell computers, programs, and various accessories.

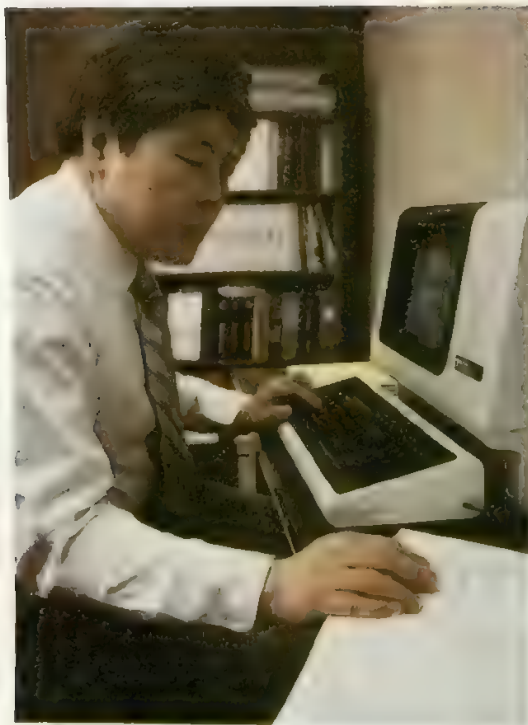
Service and repair. Because people depend on their computers, it is important to have the machines serviced periodically and repaired promptly when necessary. Many computer manufacturers offer service contracts that provide for regular maintenance and prompt repairs. When a large computer system breaks down, service technicians must visit the computer itself. Some large businesses and institutions have their own computer maintenance staffs.

Many retail outlets that sell personal computers also offer repair service to their customers. These retailers allow their customers to bring computers back to the shop for servicing or repairs.

Careers. There are many career opportunities in the computer industry. Computer engineers are probably the most technically specialized computer experts. Hardware engineers design the circuits that are engraved on chips, and they develop and design the wiring that lets information flow smoothly through the computer. Engi-



A repair specialist services a personal computer, above. Many computer makers and dealers provide repair services.



Computer programmers write instructions for computers to follow. This programmer is entering a program into a computer.

neers also design the technical aspects of memory, file storage, and peripheral equipment.

Computer programmers write the instructions that make computers operate properly. Systems analysts determine the most efficient use of computers for a particular situation. They study entire computer systems—hardware and software—and the purpose a computer is intended to serve.

Software publishers make up another career area. People in this field issue programs, write and edit instruction manuals, and provide technical services for customers.

Many career opportunities in computers exist outside the computer industry itself. For example, data processors enter information into computers. Workers in many industries oversee the computers that control machines.

Some of the industry's most successful individuals are self-taught. But most computer careers call for a college degree. College courses that help prepare students for careers in computers include programming, electronics, systems analysis, and data processing.

The development of the computer

The ideas and inventions of many engineers, mathematicians, and scientists led to the development of the computer. The ancient abacus served as the earliest sort of calculating device. But its use was limited by the need to move each counter individually (see *Abacus*).

Early calculating devices. The first true calculating machines were developed in the 1600s. In 1642, the French mathematician, scientist, and philosopher Blaise

Pascal invented the first automatic calculator. The device performed addition and subtraction by means of a set of wheels linked to each other by gears. The first wheel represented the numbers 1 to 10, the second wheel represented 10's, the third stood for 100's, and so on. When the first wheel was turned 10 notches, a gear moved the second wheel forward a single notch. The other wheels became engaged in a similar manner.

In the early 1670s, the German mathematician Gottfried Wilhelm von Leibniz extended the usefulness of Pascal's calculator. Leibniz's improvements included gear and wheel arrangements that made multiplication and division possible.

Leibniz also sought a counting system that would be easier for a machine to handle than the decimal system. He developed the binary system of mathematics in the late 1600's. Binary mathematics uses only the 0 and the 1, arranging them to represent all numbers.

An important contribution to the development of binary mathematics was made in the mid-1800's by George Boole, an English logician and mathematician. Boole used the binary system to invent a new type of mathematics. *Boolean algebra* and *Boolean logic* perform complex mathematical and logical operations on the symbols 0 and 1. Thus, a mechanical representation of binary mathematics would require the representation of only those two digits. This advance had a major effect on the development of computer logic and computer languages.

Early punched-card computing devices. A French textile weaver named Joseph Marie Jacquard made the next great contribution to the development of the computer. In the weaving process, needles directed thread to produce patterns. In 1801, Jacquard invented the *Jacquard loom*, which used punched cards to automate this process for the first time. The cards had patterns of holes punched in them, and were placed between the rising needles and the thread. The presence or absence of a hole could be compared to the two digits of the binary system. Where there were holes, the needles rose and met the thread. Where there were no holes, the needles were blocked. By changing cards and alternating the patterns of punched holes, it became possible to mechanically create complex woven patterns.

The punched cards of the Jacquard loom inspired the English mathematician Charles Babbage. During the 1830s, Babbage developed the idea of a mechanical computer that he called an *analytical engine*. He worked on the machine for almost 40 years. When performing complex computations or a series of calculations, the analytical engine would store completed sets of punched cards for use in later operations. Babbage's analytical engine contained all of the basic elements of an automatic computer—storage, working memory, a system for moving between the two, and an input device. But the technology of Babbage's time was not advanced enough to provide the precision parts he needed to construct the machine, and he lacked funding for the project. Babbage, like others of his time, also lacked an understanding of the nature and use of electricity.

The first successful computer. In 1888, American inventor and businessman Herman Holerith devised a punched card system, including the punching equipment, for tabulating the results of the United States cen-



The punched-card tabulating machine invented by Herman Hollerith was the first successful computer. It was used to compute the results of the 1890 United States census, *above*.

sus (see Census). Hollerith's machines used electrically charged nails that, when passed through a hole punched in a card, created a circuit. The circuits registered on another part of the machine, where they were read and recorded. Hollerith's machines tabulated the results of the 1890 census in the United States, making it the fastest and most economical census to date. In a single day, 56 of these machines could tabulate census information about more than 6 million people.

Hollerith's tabulator enjoyed widespread success. Governments, institutions, and industries found uses for the machine. In 1896, Hollerith founded the Tabulating Machine Company. He continued to improve his machines during the following years. In 1911, he sold his share of the company. Its name was changed to the Computing-Tabulating Recording Company (C-T-R). In 1924, the name was changed to International Business Machines Corporation (IBM).

The first analog computer. Vannevar Bush, an American electrical engineer, worked to develop a computer that would help scientists. In 1930, he built a device called a *differential analyser* to solve differential equations. This machine was the first reliable analog computer. It derived measurements from the movements of its gears and shafts.

The first electronic computers. Some scientists and engineers saw greater computing potential in electronics. The first special-purpose electronic digital computer was constructed in 1939 by John V. Atanasoff, an American mathematician and physicist. In 1944, Howard Aiken, a professor at Harvard University, U.S.A., built another early form of digital computer, which he called the Mark I. The operations of this machine were controlled chiefly by electromechanical *relays* (switching devices).

In 1946, two engineers at the University of Pennsylvania, U.S.A., J. Presper Eckert, Jr., and John William Mauchly, built the first general-purpose electronic digital computer. They called it ENIAC (*E*lectronic *N*umerical *I*ntegrator *A*nd *C*omputer). ENIAC contained about 18,000 electronic valves, which replaced the relays that had controlled the operation of Mark I. The machine weighed more than 27 metric tons, occupied more than 140 square metres of floor space, and consumed 150 kilowatts of electricity during operation. ENIAC operated about 1,000 times as fast as the Mark I. It could perform about 5,000 additions and 1,000 multiplications per second, and could store parts of its programming.

Although ENIAC performed its work rapidly, programming the huge machine took a great deal of time. Eckert and Mauchly next worked on developing a computer that could store even more of its programming. They worked with John von Neumann, a Hungarian-born American mathematician. Von Neumann helped assemble all available knowledge of how the logic of computers should operate. He also helped outline how stored-programming techniques would improve computer performance.

In 1951, a computer based on the work of the three men became operational. It was called EDVAC (*E*lectronic *D*iscrete *V*ariable *A*utomatic *C*omputer). EDVAC strongly influenced the design of later computers.



ENIAC, completed in 1946, was the first general-purpose electronic digital computer. The enormous machine was invented by J. Presper Eckert, Jr., *front left*, and John W. Mauchly, *centre*.

Also in 1951, Eckert and Mauchly invented a more advanced computer called UNIVAC I (*UN*iversal *Automatic* Computer). Within a few years, UNIVAC I became the first commercially available computer. Unlike earlier computers, UNIVAC I handled both numbers and alphabetical characters equally well. It also was the first computer system in which the operations of the input and output equipment were separated from those of the computing unit. UNIVAC I used electronic valves to perform arithmetic and memory-switching functions.

The first UNIVAC I was installed at the U.S. Bureau of the Census in June 1951. The following year, another UNIVAC I was used to tabulate the results of the United States presidential election. Based on available data, UNIVAC I accurately predicted the election of President Dwight D. Eisenhower less than 45 minutes after the polls closed.

The miniaturization of computer components.

The invention of the transistor in 1947 led to the production of faster and more reliable electronic computers. Transistors control the flow of electric current in electronic equipment. They soon replaced the bulkier, less reliable electronic valves. In 1958, Control Data Corporation introduced the first fully transistorized computer, designed by American engineer Seymour Cray. IBM introduced its first transistorized computers in 1959.

Miniaturization continued with the development of the integrated circuit in the early 1960's. An integrated circuit contains thousands of transistors and other tiny parts on a small silicon chip. This device enabled engineers to design both minicomputers and high-speed mainframes with tremendous memory capacities.

Despite the shrinking size of their components, most computers remained relatively large and expensive. But dependence on computers increased dramatically. By the late 1960's, many large businesses relied on computers. Many companies linked their computers together into networks, making it possible for different offices to share information.

During the 1960's, computer technology improved rapidly. Different kinds of circuits were placed on silicon chips. Some of the circuits contained the computer's logic. Other chips held memory. By the early 1970's, the entire workings of a computer could be placed on a handful of chips. As a result, smaller computers became



IBM's personal computer, introduced in 1981, enjoyed great success. The small size and low cost of the computers made them popular among individuals, schools, and businesses

possible. The central chip that controlled the computer became known as a *microprocessor*.

The personal computer. The first personal computer, the Altair, was introduced in 1975. Only electronics hobbyists bought these computers.

In 1977, two American students, Steven P. Jobs and Stephen G. Wozniak, founded the Apple Computer Company and introduced the Apple II personal computer. The Apple II was much less expensive than mainframes. As a result, computers became available to people other than computer specialists and technicians. Personal computers were purchased by small and medium-sized businesses that could not afford mainframes or did not need the immense computing power that mainframes provided. Millions of individuals, families, and schools also bought them.

In 1981, IBM entered the personal computer market with its PC. The machine was even more successful than the Apple II. Apple scored another success in 1984 with the introduction of its Macintosh, a powerful, easy-to-use desktop computer.

As computer power increased, so did computer speed. These increases were accompanied by a steady reduction in both size and cost. Modern personal computers are more powerful than UNIVAC I and can be purchased for less than \$1,000.

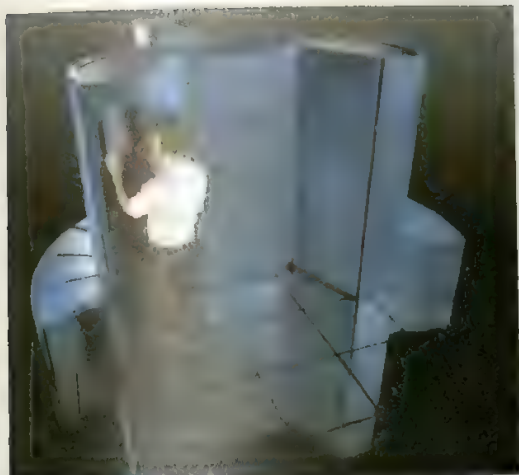
Computers of the future. Tomorrow's computers will be increasingly powerful. Computer researchers continue to seek ways to develop faster and more powerful machines and software. Much software research focuses on the further development of artificial intelligence, which is intended to help computers make decisions rather than simply to manipulate data. One type of artificial intelligence, the expert system, translates patterns of experience into software. An expert system responds to input by asking questions and providing responses. In this manner, it constantly narrows the field of inquiry until a solution is achieved.

Much effort also is being devoted to making computers smaller. In the near future, most experts feel that computers will continue to be built from integrated circuits. But some scientists foresee the production of biological computers, which will be grown rather than manufactured. In addition, some experts believe that computer technology will develop methods of storing data on individual molecules. A molecular storage system could contain all of the knowledge of the human race in a space smaller than a paperback book.

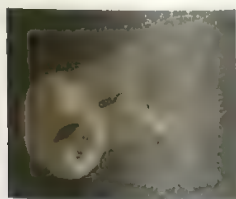
Problems of the computer age

Because computers provide such convenient storage for large amounts of information, less and less information is stored on paper. Much of the convenience of computers stems from their ability to form networks by means of telephone lines. But a computer that makes up part of a network resembles a room with many doors. Intruders who slip through these "doors" are difficult to trace. For this reason, computer designers work to safeguard stored information from unauthorized access, as well as from system breakdown or failure.

Computers and privacy. Many people fear that their right to privacy is threatened by the possible misuse or unauthorized disclosure of information in computer databases. Databases often contain private and personal



A supercomputer can solve large, complicated numerical problems with amazing speed. The Cray supercomputer shown above generated a detailed image of part of the main engine of a space shuttle, left.



information, such as medical, banking, or tax records. Other databases pertain to business plans or inventions that a company must conceal from competing companies. Still other databases store top-secret military information or other kinds of data important to a nation's security. Today, laws control the disclosure of data.

Computers and security. Computer operating systems are designed to prevent unauthorized entry into a computer, but computer crimes sometimes occur. Industrial spies and thieves often use telephone lines to gain access to computers. Some of these criminals steal or change the information in a computer database. Others steal money by using the capability of computers to transfer funds electronically from one account to another. Major problems can result if someone obtains illegal access to secret information in government or corporate databases. Sometimes, people within an organization commit computer crimes. Other crimes are committed by outsiders who create chaos by breaking into computer systems.

In the late 1980's, computer experts became aware of a dangerous type of program called a *computer virus*. A computer virus is designed to do mischief, sometimes by deleting or changing information and sometimes by simply inserting a message. A virus eventually enters a computer's operating system. It spreads by rapidly making copies of itself, thus "infecting" the other computer systems in a network. This process can quickly overload huge computer networks.

Various methods help safeguard computer systems and databases. Protective measures are built into many computer operating systems to prevent access by invaders. Many computers require a user to enter a secret password. Some systems automatically scramble information so that it can only be decoded by authorized

personnel. Careful protection of these passwords and codes helps decrease the likelihood of illegal access.

Other problems. Computers are valuable in many ways. But if a computer breaks or is damaged, the people who rely on it face great difficulties. Until the computer is fixed, these people may be worse off than if they never had a computer at all. For example, information may be lost if a computer system suffers damage in a natural disaster, such as a fire or flood. Computer breakdowns and faulty programming in business organizations delay transactions, disrupt work, and create inconveniences for consumers. An undetected computer malfunction at an air traffic control centre could cause a collision. A computer failure at a national defence installation could have even more serious consequences.

Computers, together with their programs, are the most complicated machines in history—and, arguably, the most useful. Modern industrial societies depend on computers in the home, school, and workplace. As computers become more powerful and widespread, computer education must continue to increase as well.

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| Electronics | |

Outline

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 - A. Solving numerical problems
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 - D. Other uses
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 - C. Mainframes
- IV. How a computer works
 - A. Entering and encoding data and instructions
 - B. Processing data
 - C. Decoding the results and producing output
 - D. Storing information
- V. Programming a computer
 - A. Preparing a program
 - B. Using programming languages
- VI. The computer industry

A. Manufacturing	C. Sales
B. Research and development	D. Service and repair
	E. Careers
- VII. The development of the computer
- VIII. Problems of the computer age

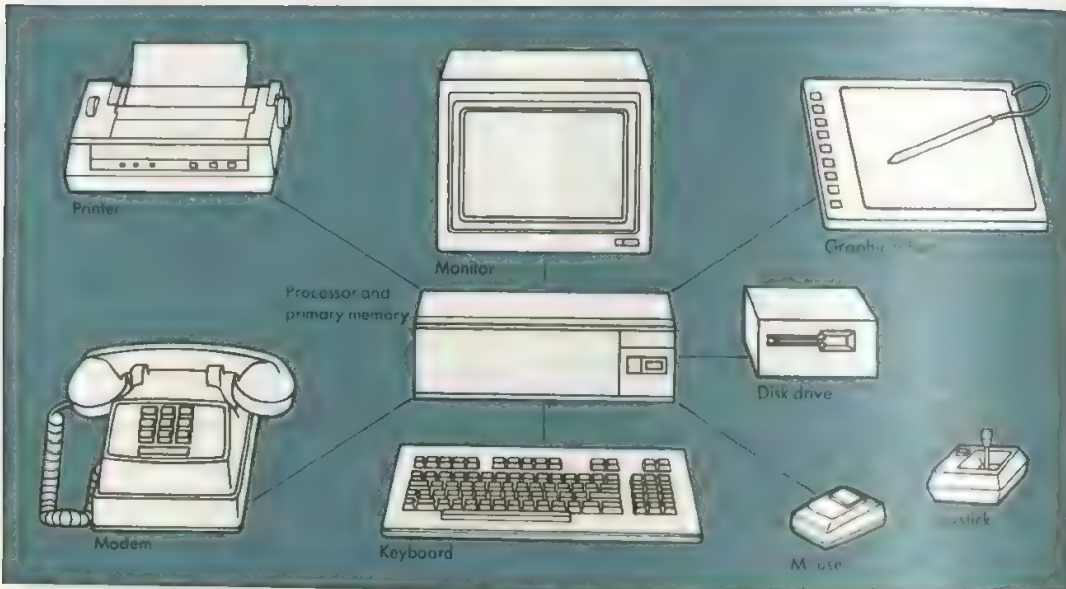
A. Computers and privacy	C. Other problems
B. Computers and security	

Questions

- What is an expert system?
 How does the binary system differ from the decimal system?
 What role does the digital logic unit play in processing?
 How do scientists use computers to develop theories?
 What is an operating system?
 How has the transistor affected computer technology?

A personal computer system

A personal computer system has many uses in businesses and in the home. The parts that make up such a system vary according to the needs of the user. The illustration below shows some of the hardware in a basic personal computer system.



- What is a computer virus?
- How does a modem work?
- Why can mainframes satisfy the needs of many users at once?
- Why did the computer industry's rate of growth increase dramatically during the late 1970's?

Computer, Personal, is a desktop or handheld computer designed for general-purpose use. Personal computers are used by individuals, families, schools, or companies for such purposes as keeping records, writing reports, learning a new subject, playing games, programming, or even running household appliances.

All computers store and handle information. Many large businesses use large, expensive computers that must be shared by a number of people to be economical. Personal computers, however, are smaller than such business computers, because they are equipped with one or more *microprocessors*. Microprocessors, which were introduced in 1971, are miniature electronic devices that can handle many of the same tasks as a large computer, though more slowly and with smaller amounts of information. The development of microprocessors led to a reduction in the cost of computers and thus made it possible for computers to be purchased by individuals, schools, and small companies.

Uses of a personal computer

Like other computers, personal computers can be instructed to perform a variety of individual functions. A set of instructions that tells a computer what to do is called a *program*. Today, more than 10,000 application programs are available for use on personal computers. They include such popular programs as *word processing programs*, *spreadsheet programs*, *database programs*, and *communication programs*.

Word processing programs are used to type, correct,

rearrange, or delete text in letters, memos, reports, and school assignments. Spreadsheet programs enable individuals to prepare tables easily. The users of such programs establish rules for handling large groups of numbers. For example, using a spreadsheet program, a person can enter some numbers into a table and the program will calculate and fill in the rest of the table. When the user changes one number in the table the other numbers will change according to the rules established by that user. Spreadsheets may be used for preparing budgets and financial plans, balancing a checkbook, or keeping track of personal investments.

Database programs allow a computer to store large amounts of *data* (information) in a systematic way. Such data might include the name, address, telephone number, salary, and starting date of every employee in a company. The computer could then be asked to produce a list of all employees who receive a certain salary.

Communication programs connect a personal computer to other computers. People can thereby exchange information with one another via their personal computers. In addition, communication programs enable people to link their personal computers with *databanks*. Databanks are huge collections of information stored in large centralized computers. News, financial and travel information, and other data of interest to many users can be obtained from a databank.

Other programs include recreational and educational programs for playing games, composing and hearing music, and learning a variety of subjects. Programs have also been written that turn household appliances on and off. Some people develop their own programs to meet needs not covered by commercially prepared programs. Others buy personal computers mainly to learn about computers and how to program them.

Hardware

The physical equipment that makes up a computer system is called *hardware*. The two most important pieces of hardware are the *primary memory* and the *processor*. The primary memory, sometimes called the *main memory*, stores information and programs in the computer. The processor in a personal computer is a microprocessor. It carries out programs and transforms information. Adding or subtracting numbers, arranging text, and producing pictures and sounds are all ways the processor transforms data. A processor works very fast. It can carry out more than 5 million logical operations in a single second.

Equipment other than the processor and primary memory is called *peripheral hardware*, and the individual devices are sometimes called *peripherals*. Peripheral hardware includes *input devices*, *output devices*, *secondary memories*, and *communication devices*.

Input devices are used for entering data and programs into the computer. A keyboard for typing words and numbers—and thus entering them into the computer—is one of the most common input devices. A *mouse* can also be used to give commands to a computer. When this handheld box is moved on a flat surface, it causes a pointer to point at a specific instruction or other data displayed on a computer screen. Clicking a button on the mouse causes the instruction to be carried out or the data to be selected for use elsewhere. Other input devices include a *joystick* for moving figures about on a screen and a *graphic tablet* consisting of a pad and a "wired" pen for producing illustrations.

Output devices let a person get information from the computer. They include a *monitor* (television screen) for showing text and pictures, a *printer* for producing data on paper, a *plotter* for making drawings, and a speaker for producing sounds.

A secondary memory, also called an *auxiliary memory* or *mass storage*, is used for storing data and programs for long periods of time. Secondary memories are generally bigger and less expensive—but slower—than the main memory, which is built into the computer itself.

The two chief kinds of secondary memory are magnetic disks and magnetic tapes. The disks are much faster than the tapes. Some disks, called *floppy disks* or *diskettes*, are made of flexible material and can be removed from the *disk drives* that operate them. Diskettes can store about 1 million characters (letters or numbers). Other disks, called *hard disks*, hold tens of millions of characters and generally are not removable. They are often installed in the same case as the processor. Hard disks are more expensive than floppy disks, but they are faster and more convenient. All the computer's programs and other data can be kept on a hard disk so that they can all be used without having to change disks.

Communication devices connect computers to one another. These devices include *modems*, which connect a computer to a telephone. Modems enable a computer to transmit data to other computers via telephone lines or other communications networks, and to receive data from distant computers. Communication devices called *local area networks* connect computers in the same building directly to one another. They provide much faster communication than do modems.

Software

The programs that tell various parts of a computer what to do are called *software*. A program is made up of many instructions that direct a variety of activities. For example, some tell the processor to move data from one part of the computer to another, such as from the keyboard to the primary or secondary memory. Others control how the computer transforms information. In addition, they tell the computer to remember as a single new instruction a program made up of many old instructions. Whenever the new instruction, called a *procedure*, is used, all the old instructions are carried out.

The instructions used to write a program make up a *programming language*. There are several levels of increasingly easy-to-use programming languages, from *machine language* through *assembly language* to *higher level languages*. Higher level languages are easy to use because they allow the user to give the computer such commands as *draw a circle*, *move this paragraph*, or *print this letter*. For more information on programming languages, see *Computer (Programming a computer)*.

How to choose a personal computer

The chief factors involved in the selection of a personal computer are the buyer's needs and budget. For example, before choosing a personal computer, you need to know whether you plan to use it mainly for one purpose—such as word processing—or for many different purposes. Different software is available for different types of computers, and so the types of functions a particular computer can perform vary. In addition, the amount of memory in the computer determines the length of a program that a computer can handle as well as the speed with which the computer will work. If you wish to run useful programs, you will need a computer with a memory of at least 256K. Such a computer is able to store more than 256,000 characters in primary memory. For more specialized programs, you may need as many as 1 million characters in primary memory.

Needs and budget also influence the selection of the peripheral hardware. A computer system that uses a home television screen will be less expensive than one with its own monitor screen. A television screen, however, will not be as clear or show as much text as a monitor. Also, if you want to draw pictures or graphs, you should choose a computer and screen that can handle graphics and perhaps colour.

To get a paper copy of work done by the computer, you will need a printer. Inexpensive printers are slow, printing about 30 characters per second. The printed copy may also be hard to read. Letter-quality printers can be faster and can produce better-quality copy than other printers, but are more expensive.

If you plan to write long reports or wish to handle a large amount of data, you should have a two-diskette system. Copying information and programs from one diskette to another is much easier and faster with this system. Or, you may decide to buy a computer with a hard disk for handling large amounts of data.

To send electronic mail to other computer users or to use information from databanks, you will need a modem. Modems vary in cost and in the speed at which they transmit information.

History

During the 1940's, scientists developed the *transistor*, a tiny device that controls electronic signals. By the early 1960's, researchers had succeeded in building integrated circuits by arranging thousands of transistors and other electronic parts on tiny slices of silicon called *silicon chips*. The first microprocessors were produced in 1971. The development of microprocessors made small, inexpensive *microcomputers* such as personal computers possible.

Electronic games played with a television set provided one of the first popular uses for microcomputer technology. During the early 1970's, manufacturers began selling personal computers.

See also Computer; Integrated circuit; Microprocessor.

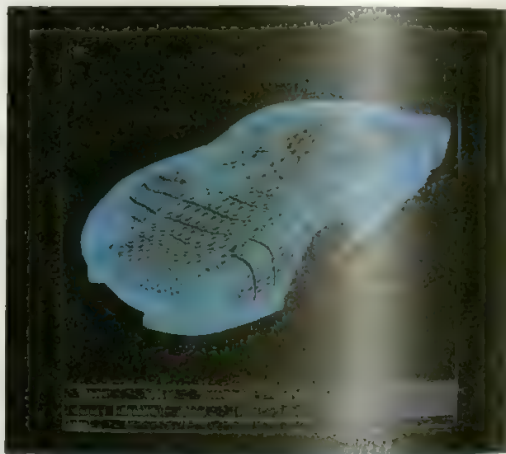
Computer graphics are images created by a computer. These images include diagrams, cartoon animations, and even highly realistic pictures. The process by which computers draw, colour, shade, and manipulate images is also known as computer graphics. Computer graphics enable us to gather, display, and understand information quickly and effectively. Computer graphics can even produce images of objects and processes that we have no other way of seeing, such as the inside of a molecule or the operation of a black hole.

Computer graphics have numerous uses in a wide variety of fields. Businesses follow sales from charts and graphs made by computers. Computer graphics help engineers create and test designs for such products as cars and aircraft. Through computer graphics, architects can view building designs drawn in three dimensions from any angle. Scientists use computer graphics to design new drug molecules, track weather systems, and test theories that describe how galaxies develop. Doctors use computer images of the inside of the body to locate tumours and other disorders and plan treatment (see Computerized tomography (CT)). Computer graphics are also used in art, in the production of cartoons and special effects in films, and in video games.

Computer graphics are created on a computer display screen, which resembles a television screen. The screen consists of thousands of tiny dots called *picture*

Creating pictures with computers

These illustrations show how computers enable manufacturers to examine and evaluate designs for products like this car without building models. The image takes shape in steps



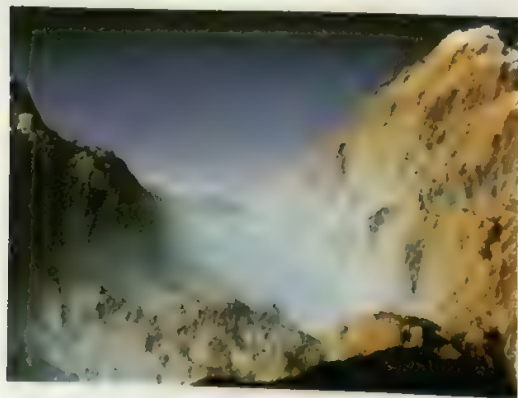
In the first step, the computer "draws" an outline of the car with a meshlike pattern of lines.



In the second step, the computer fills in the spaces between the lines to show what the car's surface looks like.



In the third step, the computer adds colour, shadows, reflections, and highlights to create a realistic image.



Using complex geometric shapes called *fractals*, a computer graphics program can create forms—like these mountains—that resemble the irregular shapes found in nature.

elements, or pixels. You can see individual pixels by looking closely at the letters that appear on a computer screen. A computer can turn each pixel on and off like a light bulb to make a pattern. Different combinations of pixels can produce any picture we want.

All computers need a *program* that tells them what to do. A computer graphics program directs the drawing on a computer's screen. The program may generate the image itself or it may copy an image from another source. For example, a program that draws molecules might start by solving equations that describe molecular structure. It can then use the solutions to display the shape of a molecule. But a program that copies a photograph might first convert points on the image into a list of numbers. The numbers can then instruct the computer which pixels to turn on and off.

See also Computer (The importance of the computer). **Computerized tomography (CT)** is an X-ray system used to produce images of various parts of the body, such as the head, heart, and abdomen. Doctors use CT images to help diagnose and treat diseases. The technique is also called *computer tomography* or *computerized axial tomography (CAT)*.

To produce a CT image, the patient lies on a table that passes through a circular scanning machine called a *gantry*. The table is positioned so that the organ to be scanned lies in the centre of the gantry. A tube on the gantry beams X rays through the patient's body and into special detectors that analyse the image produced. The gantry rotates around the patient to obtain many images from different angles. A computer then processes the information from the detectors to produce a cross-

sectional image on a video screen. By moving the table in the gantry, doctors can obtain many scans of the same organ or even the entire body.

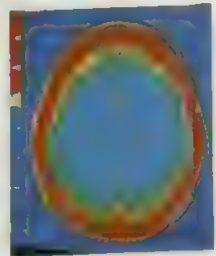
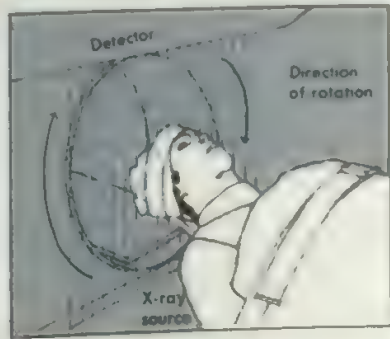
Sometimes an iodine solution, called a *contrast agent*, is injected into the body to make certain organs show up clearly in the CT scan. For scans of the abdomen and pelvis, the patient drinks a barium mixture (which is opaque to X rays) to outline the inner surfaces of the stomach and bowel.

Doctors use CT scans to diagnose many conditions, such as tumours, infections, blood clots, and broken bones. CT also assists in treating some diseases that might otherwise require surgery. For example, doctors can use a CT scan to guide *catheters* (small tubes) to an abscess in the body and drain pus from the infected area.

See also Radiology; X ray.

Comte, Auguste (1798-1857), was a French social thinker and philosopher. He founded the philosophy of *positivism*, and originated a concept of social science known as *sociology*.

Comte sought to discover the laws that he believed governed the evolution of the mind. In his six-volume work, *The Course of Positive Philosophy* (1830-1842), he framed his "law of the three states." This law advanced the idea that people try to understand phenomena in three ways. Comte believed that people first seek a *theological* (supernatural) explanation, then a *metaphysical* (abstract) explanation, and finally a *positive* explanation. The positive explanation is derived from an objective examination of the phenomena. Comte believed that students should concern themselves only with phenomena



A CT scanner is an X-ray machine that makes a cross-sectional view of the brain and other internal organs. It shoots X rays through a patient's body from many angles. An X-ray detector measures the rays that penetrate. A computer reads the data from the detector and then forms an image on a screen. The scanner thus produces a detailed picture of the brain, right.

that have an objective, "positive," existence. This belief forms a basis of positivism.

Comte regarded all social thought as an interrelated whole, the laws of which can be found by assembling what he considered the facts. His ideas have influenced students of historical and social theory, and of criminology, and such authors as Herbert Spencer and John Stuart Mill, who were seeking a "science of society." Comte was born at Montpellier, in France.

See also **Positivism; Sociology (History)**.

Conakry (pop. 763,000) is the capital, largest city, and chief port of Guinea. For location, see **Guinea** (map). The oldest part of Conakry lies on the island of Tombo at the tip of the Camayenne (Kalamou) Peninsula. This area features low, whitewashed buildings with red-tiled roofs. The newer part of Conakry is on the mainland. It has modern office buildings and extensive areas of inexpensive housing. Conakry is a shipping and government administration centre. Its products include beverages and processed foods.

Conakry began as a small trading village in the mid-1400s. France gained control of Guinea in the late 1800s. The French made Conakry a major port and administration centre. Guinea gained independence from France in 1958. Since then, Conakry has grown rapidly, and overcrowding has become a problem.

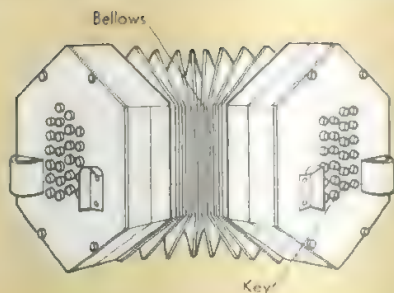
Concentration camp is a place where political enemies, real or assumed, are imprisoned, usually without trial. The term was first used by Great Britain for prison camps it set up during the Boer War in Africa around 1900. Soviet secret police imprisoned millions of people in labour camps after 1928, during Joseph Stalin's dictatorship. During World War II (1939-1945), the United States and Canada held thousands of people of Japanese ancestry in camps (see **World War II (On the Home Front)**). But the best-known concentration camps were those set up in Nazi Germany.

After the Nazis came to power in 1933, they used concentration camps to imprison political enemies and to terrorize the German people. Most early prisoners were Communists and other political opponents. Many, however, were Jews arrested on false charges. Prisoners were almost always treated brutally, and many of them died. By 1939, the Nazis had six camps, including those at Dachau and Buchenwald, in Germany.

When World War II began, the number of camps quickly increased to 22. They were filled with people of every European nationality, and included prisoners of war as well as civilians. An estimated 7 to 8 million people were imprisoned by the Nazis between 1933 and 1945. Some prisoners were sent to manufacturing plants to work. Others were forced to perform dangerous or degrading tasks in the camps or other places.

In 1942, the Nazis decided to rid Europe of all Jews. By the end of the war, they had murdered about 6 million. At first, they used firing squads. Later, they used special gas chambers to kill large groups of victims at a time with poison gas. Others died as the result of experiments performed on them by doctors and scientists. About 2½ million people were executed at Auschwitz, an extermination camp in Poland. Many others died, chiefly of starvation, at Buchenwald.

Allied forces reached the camps in 1945. They found thousands of unburied dead, and survivors who were



A concertina consists of metal reeds inside a bellows. Keys or plugs in the end plates open valves that control the reeds.

crippled, insane, or dying of disease or starvation. During the Nuremberg Trials after the war, many Nazi leaders were convicted of crimes against humanity. Some were executed.

See also **Auschwitz; Belsen; Buchenwald; Dachau**.

Conception. See **Reproduction (Fertilization)**.

Concertina is a musical instrument in which metal reeds are made to vibrate by air pressure produced by opening and closing a bellows. Small keys or plugs in the end plates of the instrument open valves that control the reeds. The treble concertina that is used the most is a small, six-sided instrument with a range of about 3½ octaves. There are also tenor, bass, and contrabass concertinas. The British inventor Sir Charles Wheatstone patented the concertina in 1829.

See also **Wheatstone, Sir Charles**.

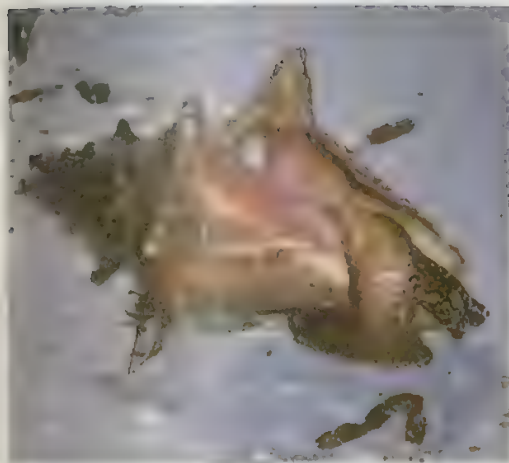
Concerto is a musical composition played by one or more solo instruments and an orchestra. A concerto resembles a symphony in form. But most concertos have only three *movements* (sections), and most symphonies have four.

The concerto developed from the *concerto grosso* of the late 1600s and early 1700s. The *concerto grosso* featured a small group of soloists playing with an orchestra. The most famous of these concertos are Johann Sebastian Bach's six *Brandenburg Concertos* (1721).

During the late 1700s, Wolfgang Amadeus Mozart wrote concertos in three movements. In the first movement, the orchestra states many of the work's themes before the soloist begins. Near the end of the movement is the *cadenza*, in which the soloist plays alone and displays his or her technical skill. In the second and third movements, the soloist and orchestra play together. The second movement is slow, and the third is fast.

During the 1800s, two types of concertos became popular. One was the *symphonic concerto*, in which the soloist and orchestra participate equally. Ludwig van Beethoven and Johannes Brahms composed this type. The other type was the *virtuoso concerto*, in which the orchestra accompanies the soloist. Niccolò Paganini, Franz Liszt, and Frédéric Chopin wrote virtuoso concertos. Composers of the 1900s generally have followed Mozart's form. These composers include Béla Bartók, Sergei Prokofiev, and Igor Stravinsky.

Conch is a large sea snail with a heavy, spiral shell. There are many kinds of conch. Conchs live in shallow



A conch is a large sea snail with a spiral shell. The *queen conch*, above, is a common North American species. It lives on the floor of the Atlantic Ocean from Bermuda to the West Indies.

water on the floor of tropical seas. They feed on fine green and red seaweeds, and also on plant fragments on the sea floor, and in sea water.

The conch has a soft body with a long, muscular organ called a *foot*. It uses the *operculum*—a pointed, hornlike part at the back end of the foot—as anchorage, digging it into the sand, rather like a spade. When the muscle connecting the operculum to the shell contracts, the conch is pulled along in a series of jerky leaps.

After mating, the female lays jellylike strands that contain up to 450,000 eggs. The tiny larva hatches out after a few days. It swims in the sea for several weeks before settling on the bottom.

A familiar species of conch shell is the *queen conch*, also called the *pink conch*, of the Caribbean. It grows to a length of about 30 centimetres. The flesh of the queen conch is valued as food and as fish bait. For thousands of years, people have used conch shells as trumpets. The shells also can be burned to make lime or ground up to make porcelain. They are prized by shell collectors. The overfishing of conchs has sharply reduced their numbers in many areas.

Scientific classification. Conchs are in the phylum Mollusca, the class Gastropoda, and the subclass Prosobranchia. The queen conch is *Strombus gigas*.

See also **Mollusc**; **Shell** (picture); **Snail**.

Conchology. See **Shell** (Collecting shells).

Concord (pop. 36,006) is the capital and third largest city in the state of New Hampshire in the United States. It is located on the Merrimack River in south-central New Hampshire. Called Penacook when it was founded in 1727, it took the name Rumford in 1733, and assumed its present name in 1765. Concord became the state capital in 1808.

Concord is the seat of Merrimack County. Government is the city's chief employer. The state, county, and city governments provide about 30 per cent of the city's jobs. Other major employers include those in the fields of medicine, law, electronics, insurance, and printing. Concord is the home of the New Hampshire Technical

Institute, the state library, the state historical society and most other state offices.

See also **New Hampshire**.

Concord, Battle of, on April 19, 1775, marked the second clash between the patriots and the British in the American Revolution. The opening battle of the war had been fought at nearby Lexington, Massachusetts. During the previous winter, the Americans had gathered military supplies in case of war. The British government ordered its commander in chief in Boston, Lieutenant General Thomas Gage, to destroy the supplies at Concord. On the night of April 18, Gage sent 700 troops under Lieutenant Colonel Francis Smith to carry out this command. But Paul Revere and William Dawes warned people in the area that the British were coming.

After a clash at Lexington early the next morning, the British continued on to Concord, 10 kilometres beyond. The Americans retreated across North Bridge, outside Concord. The main force of British troops searched for the patriots' supplies in the town, while others guarded the bridge. Several hundred colonists marched on the bridge and exchanged shots with the British troops there. Three British soldiers and two Americans were killed. A few hours later, Smith's men headed back toward Boston.

See also **American Revolution**.

Concorde. See **Aeroplane** (Supersonic aeroplanes).

Concrete. See **Cement** and **concrete**.

Concussion is a temporary disturbance of brain function caused by a sudden blow to the head. Concussion usually results in a temporary loss of consciousness, followed by a loss of memory about the events just before and after the injury. More extensive memory loss occurs if the injury is severe. Mild concussion may or may not involve unconsciousness and memory loss. It causes a momentary state of confusion.

In concussion, the blow causes the brain to bounce against the inside of the skull, injuring the brain's outer surface. Injury to the inner parts of the brain may also occur. The reason unconsciousness occurs is not well understood. One theory is that the blow disturbs the function of the *cerebral cortex* (outermost part of the brain). Another is that the blow injures the deeper parts of the brain that control sleep cycles and alertness.

The victim of concussion may stop breathing for a few seconds after the blow. In addition, the victim's pulse slows, the muscles relax, the pupils widen, and certain reflex actions disappear. Usually, the injured person regains consciousness within a few seconds and is soon alert and functioning normally. In more severe injuries, however, the person may not regain full alertness for several days.

After concussion, some people develop dizziness, headaches, ringing in the ears, or changes in behaviour. They may have difficulty concentrating. Such problems may persist for months. For information on how to treat a victim of concussion, see **First aid** (Concussion).

Condamine is a river in southeastern Queensland, Australia. It rises on the western slopes of the Great Dividing Range near the city of Warwick. The river drains the northern part of the Darling Downs, the fertile tableland 160 kilometres west of Brisbane. Two major irrigation projects are based on its system. The explorer Allan Cunningham discovered and named the river in 1827.

Condensation. See Dew; Distillation (with diagram).
Condensed-matter physics. See Solid-state physics.

Condensed milk is a pasteurized, concentrated form of milk. It is made by evaporating water from whole milk to reduce the milk's volume by about half. It is not sterilized and must be refrigerated to prevent spoilage. Condensed milk, also called *concentrated milk*, is a good source of protein, calcium, and vitamin B₂.

The partial evaporation of water from sweetened milk results in *sweetened condensed milk*. This product contains nearly 45 per cent sugar. When sealed in a can, it requires no refrigeration. Both condensed milk and sweetened condensed milk are used chiefly for making ice cream and sweets. It is also used in baking.

Condenser. See Capacitor.

Condenser, Steam. See Turbine (Steam turbines).

Conditioning. See Psychology (Behaviourism).

Condom. See Birth control (Methods of birth control).

Condor is either of two species of large vulture found in the Western Hemisphere. The *California condor*, which once lived wild in southern California, in the United States, has nearly died out. Only about 30 California condors survive, all in captivity. The *Andean condor* of South America is more common, but it also is in danger of extinction. Andean condors live in the Andes Mountains from Colombia to the Strait of Magellan, and along the coast of Peru and Argentina.

Appearance. California condors are one of the larg-

est flying land birds in the world, with a wingspan of 24 to 2.9 metres. They weigh up to 14 kilograms. The slightly larger Andean condor has a wingspread of about 3 metres and weighs up to 12 kilograms. Black feathers cover most of an adult condor's body. California condors have white on the underside of the wings. The upper wing surface of Andean condors is white. A collar of feathers circles the base of the neck—black feathers on California condors and white feathers on Andean condors. The featherless neck and head are red-orange. Male Andean condors have a fleshy crest on the head.

Habits. In the wild, condors spend much of the day resting on high perches. Condors do not build nests. Instead, their eggs are laid in caves, in holes, or among boulders. A female California condor lays just one egg every two years. A female Andean condor also reproduces only every second year, laying one or two eggs.

Condors are powerful, graceful fliers. They can soar and glide for long distances, flapping their wings an average of only once an hour. They may search the ground for food as they fly. Like other vultures, condors eat the remains of dead animals.

Outlook for the California condor. By the 1980's, only a small number of California condors survived. Many California condors had been shot. Others may have died from eating poisoned animal bodies set out to kill coyotes. Increasingly, the growth of urban areas poses a major threat to condor survival. The condors

California condor
Gymnogyps californianus
 Found only in captivity
 Body length 127 centimetres



Andean condor
Vultur gryphus
 Found in the Andes, from Venezuela and Colombia to the Strait of Magellan
 Body length 132 centimetres



way of life requires vast areas of open, hilly country, and urban growth destroys such habitat.

In 1982, biologists began a programme to capture all wild California condors. The last wild California condor was captured in 1987. Since then, several condors have been born and raised in captivity. Scientists hope to return condors to the wild in time. Nevertheless, the future of the bird remains in doubt.

Scientific classification. Condors belong to the New World vulture family, Cathartidae. The California condor is classified as *Gymnogyps californianus*. The Andean condor is *Vultur gryphus*.

See also Vulture.

Condorcet, Marquis de (1743-1794), was a French philosopher. His major work was *Sketch for a Historical Picture of the Progress of the Human Mind* (1793-1794). He believed that human nature could be perfected and that history showed humanity's progress toward an enlightened civilization. He opposed monarchy and religion. He felt that evils resulted from inadequate institutions and laws created by rulers and priests. Condorcet believed that history up to his time consisted of nine epochs (periods). In the 10th epoch, which he predicted for the future, equality would develop among nations and classes, and people would improve physically, intellectually, and morally.

Condorcet was born in Picardy. His given and family name was Marie Jean Antoine Nicolas de Caritat. He was a brilliant mathematician and was elected to the French Academy. He supported the French Revolution and served in the revolutionary Legislative Assembly and Convention. But eventually he was arrested as an enemy of the revolution. He died in prison.

Conduct. See Behaviour; Etiquette; Religion (A code of conduct).

Conducting. See Orchestra (The conductor).

Conduction. See Heat (How heat travels).

Conductor, Electrical. See Electric current (Conductors and insulators).

Cone, a part of the eye. See Eye (The retina; diagram); Colour (How we see colour).

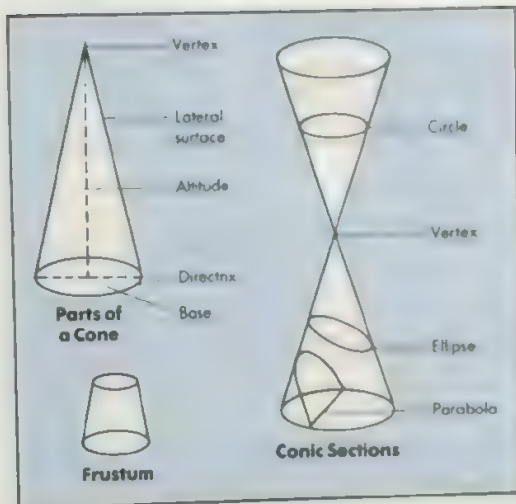
Cone, in geometry, is a solid figure whose base lies on a plane and is bounded by a closed curve called the *directrix*. The *lateral surface* (side) of the cone consists of all the line segments connecting points of the directrix to the cone's *vertex*, a fixed point not on the plane of the base. When the directrix is a circle, the cone is a *circular cone*. If the line segment from the vertex to the centre of the circle is perpendicular to the plane of the base, the cone is a *right circular cone*. When a right circular cone is intersected by a plane that does not contain the vertex, a curve called a *conic section* is formed. Circles, ellipses, hyperbolas, and parabolas are conic sections.

The *altitude* of a cone is the perpendicular line segment from the vertex to the plane of the base. The length of the altitude is the *height* of the cone. The *volume* (*V*) of a cone can be found by using the formula:

$$V = \frac{1}{3} Bh$$

In the formula, *B* stands for the area of the base and *h* for the height of the cone. If the base of the cone is a circle, then $B = \pi r^2$, where *r* is the radius of the circle. The formula for volume can then be written:

$$V = \frac{1}{3} \pi r^2 h$$



A cone is a solid figure. If the top of a cone is cut off by a plane parallel to the base, a solid called a *frustum* remains. *Conic sections* are curves formed by planes intersecting cones.

An approximate value for π (pi) is 3.1416.

In a right circular cone, all the line segments from the vertex to the directrix have the same length, called the *slant height*. The *lateral surface area* (*L*) of a right circular cone can be calculated with the formula:

$$L = \pi rs$$

In this formula, *r* stands for the radius of the base and *s* stands for the slant height. The *total surface area* of the cone equals the lateral surface area plus the area of the base.

If a plane parallel to the base of a cone passes between the vertex and the base, the cone is divided into a smaller cone and a solid figure called a *frustum*. The volume of the frustum equals the volume of the original cone minus the volume of the smaller cone.

See also Circle; Ellipse; Hyperbola; Parabola.

Cone-bearing plant. See Conifer; Cycad.

Cone shell is one of several marine snails, named after their cone-shaped shells. The shells of many species have beautiful markings. Most species live in the Indo-Pacific region, and in the waters off northern Australia.



Cone shells have a poisonous sting that is dangerous to people. They are found on coral reefs.

Cone shells prey on small marine creatures such as worms and other molluscs. They kill the prey by injecting poison through a spearlike tooth. The poison is extremely toxic and can kill humans.

Scientific classification. Cone shells are molluscs of the class Gastropoda, subclass Prosobranchia. They belong to the genus *Conus*.

Coney. See Hyrax.






Confection. See Sweets.

Confederate States of America was the name taken by six southern states of the United States when they organized their own government at Montgomery, Alabama, in February 1861. The states *seceded* (withdrew) from the government of the United States in 1860 and 1861 because they feared that the election of Abraham Lincoln, a Republican President, might lead to restrictions on their right to do as they chose about the question of slavery. The first state to leave the Union was South Carolina on Dec. 20, 1860. Mississippi, Florida, Alabama, Georgia, and Louisiana followed South Carolina's lead in January 1861. In March 1861, Texas also seceded, and later in that year Virginia, Arkansas, North Carolina, and Tennessee joined the ranks to make 11 Confederate States in all.

The idea of a state leaving the Union was not new, and the South did not invent it. Throughout the United States, people who believed in the doctrine of states' rights had long argued that any state had the right to withdraw from the Union whenever it chose. They argued that individual states had formed the Union and therefore could also dissolve it.

Government. Organization of a government for the Confederacy began on Feb. 4, 1861, when delegates from the six states that had seceded by that time met at Montgomery, Alabama, and set up a temporary government. Jefferson Davis of Mississippi was elected president of the Confederacy, and Alexander H. Stephens of Georgia was chosen vice president. Both were to serve for one year. After the adoption of a permanent constitution, they were elected to six-year terms. Montgomery was named the temporary capital. After Virginia seceded, the Confederate Congress voted on May 21, 1861, to move its capital to Richmond. The move was accomplished on May 29.

The Confederate States of America

-  Confederate states
-  Border states in the Union
-  Union states and territories
-  Confederate capitals
-  Union capital

0 400 Miles
0 400 Kilometres



The Confederate States hoped for a peaceful withdrawal from the Union. A number of people in the Confederacy and in the Union worked hard to avoid civil war. But their efforts failed, and the war began on April 12, 1861.

The border states were the slave states that lay between the North and the Deep South. When the war began, both the Union and the Confederacy made strong efforts to gain their support. North Carolina, Virginia, Arkansas, and Tennessee joined the Confederacy. Delaware, Maryland, Kentucky, and Missouri stayed in the Union. But the western counties of Virginia seceded from the South later in the war, and formed the state of West Virginia. And secessionist groups set up separate state governments in both Kentucky and Missouri, even though these states stayed in the Union. These groups also sent delegates to the Confederate Congress. This accounts for the 13 stars in the Confederate flag even though only 11 states actually joined the Confederacy.

Foreign relations. Great Britain, France, the Netherlands, Spain, and Brazil were among the countries that recognized the Confederate States as a belligerent, but not as a nation. This meant that Confederate ships received the same privileges granted to vessels of the United States in foreign ports or on the high seas.

The Confederacy suffered great financial disadvantages. The wealth of the United States, before secession, lay mainly in the North, and the South lacked adequate resources for taxation.

Progress of the war favoured the Confederacy in the first months. The defeat of the Union forces at Fredericksburg, Virginia, in December 1862, led the emperor of France, Napoleon III, to offer his services as peace-maker between the Union and the Confederacy. The Union rejected this offer.

In 1863, the tide began to turn against the Confederacy. The Union armies could get more materials and supplies from the industrial North than the Confederate armies could obtain from the agricultural South. The North kept its army supplied with ammunition, food, and clothing, while the army of the South often lacked these supplies. Union ships blockaded Southern ports. The only way the South could bring in necessary supplies from overseas was to run the blockade. But South-

ern soldiers fought bravely until there was no longer any hope of victory.

The Confederate Congress met often during the war, mainly to follow the bidding of President Davis, who freely used his war powers. Union forces took Richmond on April 3, 1865. Danville, Virginia, then became the capital of the Davis government. The main Confederate army surrendered on April 9, 1865. The road to reunification in spirit between the North and the South was long, but by the beginning of the 1900's resentment had been largely forgotten.

Related articles in *World Book* include:

American Civil War
Davis, Jefferson

Fort Sumter
Lee, Robert E.

Confederation, Articles of. See **Articles of Confederation.**

Confederation of British Industry (CBI) is a non-party political body in the United Kingdom that represents more than 250,000 British businesses. It aims to convey members' views to the government and the public on topics such as the importance of wealth creation, and the needs and problems of the business community. The CBI also represents nearly 200 trade associations and employers' organizations.

The CBI's policies are decided by a central council of 400 members, which meets monthly in London. It has more than 100 specialist committees, subcommittees and working parties. The CBI also has 13 regional councils, and a smaller firms' council. The CBI National Conference is held each November. The CBI has a staff of about 350 people, headed by a director-general.

The CBI was founded in 1965 by the amalgamation of the British Employers Confederation, the Federation of British Industries, and the National Association of British Manufacturers.

Confederation of Irish Industry (CII) is an organization that represents industry in the Republic of Ireland. It promotes its members' views on trade, economics, finance, taxation, planning, and development. The CII has about 1,200 members, including both private and state-sponsored enterprises. Originally founded in 1932 as the Federation of Irish Manufacturers, the CII adopted its present name early in 1970.

Conference on Security and Cooperation in Europe (CSCE) is any of a series of conferences designed to increase cooperation between certain Eastern and Western European nations. Until late 1991, the participants were the Soviet Union and all the other countries in Europe, plus the United States and Canada. In 1991, the Soviet Union broke up into a number of independent states. As a result, Russia assumed the Soviet Union's seat, and many of the other states that had been part of the Soviet Union joined the CSCE. A number of these states are in western and central Asia. Today, about 50 countries officially participate in the CSCE.

The first of many CSCE conferences met in 1975 in Helsinki, Finland. The conferences eased international tensions. They also stimulated the formation of human rights groups that helped overthrow many one-party Communist governments in Eastern Europe and in the Soviet Union. In 1990, a CSCE conference in Paris officially declared an end to the Cold War, a period of great hostility between the Communist and non-Communist nations. The Paris conference established a CSCE secre-

tariat in Prague, in what is now the Czech Republic; a conflict-resolution centre in Vienna, Austria, and in Warsaw, Poland, an office to monitor elections in European countries.

See also **Helsinki Accords.**

Confession, in law, is a voluntary statement in which a person admits that he or she is guilty of a crime. A confession also describes how the crime occurred. Confessions form part of criminal law, which involves actions harmful to society.

In many countries, courts classify confessions into two basic groups. *Judicial confessions* are made during court proceedings. *Extrajudicial confessions* are made outside court, to officers of the law or to people who are not officials. Judges do not allow involuntary confessions to serve as evidence or proof in court. These confessions are obtained improperly, by such methods as injuring, threatening, or making promises to a suspect.

In most common law countries there are established safeguards which must be observed when questioning suspects. For example, before police question a person in custody, they must inform that person of certain rights. The person has the right to remain silent and to have a lawyer present when being questioned by the police. If the police do not observe a suspect's rights, the court will not accept as evidence the statements the suspect made to them.

In cases involving civil law, rather than criminal law, statements made by a party to a lawsuit are called *admissions* if the statements are against the party's own interest. Civil law covers such matters as contracts, personal injuries, and property ownership. Admissions may serve as evidence.

See also **Evidence.**

Confession, in religion. See **Eastern Orthodox Churches** (Sacraments); **Roman Catholic Church** (The seven sacraments).

Confirmation is a religious ceremony practised by several faiths. In the Roman Catholic, Eastern Orthodox, and Lutheran churches, and in the Church of England, it is associated with baptism. Roman Catholics believe that it confers the grace of the Holy Spirit on baptized people. In Protestant churches, the baptized renew or affirm the promises made for them at baptism. In Judaism, boys are confirmed at the age of 13 in a ceremony called *bar mitzvah*. Some synagogues have similar ceremonies for girls called *bat mitzvah*. Many also hold a confirmation exercise on Shavuot (see **Shavuot**). See also **Baptism**; **Bar mitzvah**; **Bat mitzvah**.

Conflict of interest occurs if an individual has a financial or other interest in a company doing business with his or her employer. For example, a person working for a government agency that awards contracts to private industry may have a financial interest in a company bidding for these contracts. A conflict of interest occurs if the government employee favours the company in which he or she has an interest. The conflict-of-interest issue often arises when business executives take positions in government. Full-time government employees must give up all outside financial interests that might conflict with their duties.

Confucianism is a philosophy based on the ideas of the Chinese philosopher Confucius. It originated about 500 B.C. From the 100's B.C. to the A.D. 1900's, Confucian-

ism was the most important single force in Chinese life. It influenced Chinese education, government, and attitudes toward correct personal behaviour and the individual's duty to society.

Many people consider Confucianism a religion. But Confucianism has no clergy and does not teach the worship of a God or gods, or the existence of a life after death. Confucianism can more accurately be considered a guide to morality and good government.

Early Confucianism. Confucius was born about 551 B.C. At that time, constant warfare raged among the many states that made up China. Rapid political change altered the structure of Chinese society, and many people no longer respected the established standards of behaviour. Confucius feared that this threat to orderly social life would lead to the destruction of civilization.

Confucius believed his society could be saved if it emphasized sincerity in personal and public conduct. The key to orderly social life was the gentleman. Confucius defined a gentleman not as a person of noble birth, but as one of good moral character. A gentleman was truly reverent in worship and sincerely respected his father and his ruler. He was expected to think for himself, guided by definite rules of conduct. Confucius formulated many of these rules into sayings. For example, Confucius taught a version of the golden rule—"What you do not wish for yourself, do not do to others" (see **Golden rule**). A gentleman also studied constantly and practised self-examination. He took, as Confucius said, "as much trouble to discover what was right as lesser men take to discover what will pay."

Confucius believed that when gentlemen were rulers, their moral example would inspire those beneath them to lead good lives. Virtuous behaviour by rulers, he declared, had a greater effect in governing than did laws and codes of punishment.

When Confucius died about 479 B.C., he was largely unknown. His followers spread his ideas. The most important early Confucian philosophers were Mencius (390?-305? B.C.) and Xunzi (mid-200's B.C.). Mencius believed people were born good. He stressed the need to preserve "the natural compassion of the heart" that makes people human. Mencius emphasized the past as an ideal age and a model for examining present problems. In contrast, Xunzi believed people could be good and live together peacefully only if their minds were shaped by education and clear rules of conduct.

By about 200 B.C., the first large, unified Chinese empire had begun. The rulers approved of Confucianism's emphasis on public service and respect for authority. In 124 B.C., the government established the Imperial University to educate future government officials in Confucian ideals. The university based its teachings on five books of Confucian thought called the *Five Classics*. Mastery of the *Classics* became proof of moral fitness and the chief sign of a gentleman.

Later Confucianism. The early Confucianists concerned themselves primarily with the needs of society. However, ideas from Taoism and other philosophies helped shift the emphasis to additional areas of human experience. For example, a person's ability to live in harmony with nature was a minor issue to Confucius. But it became an important theme in Confucian thought during the 200's and 100's B.C.

From about A.D. 200 to 600, interest in Confucianism declined in China. Many Chinese turned instead to Buddhism and Taoism. These religions dealt with problems that the teachings of Confucianism largely ignored, such as the meaning of suffering and death.

A revival of interest in Confucius' philosophy began in the 600's. By the 700's, candidates for government jobs had to take a civil service examination based on Confucian ideas. The examination carried out Confucius' belief that an enduring state must be built on the merit of its rulers' advisers.

Zhu Xi (1130-1200) became a leader of a movement called *Neo-Confucianism*. Zhu developed a branch of Neo-Confucianism called the *rational wing*. It emphasized study and investigation of *Li*, the pattern behind human and natural relationships. Scholars led by Wang Yangming (1472-1529) developed the *intuitive wing* of Neo-Confucianism. They sought enlightenment by a combination of meditation and moral action.

Confucianism continued to actively influence Chinese life until it came into conflict with Western ideas, especially Communism, in the 1900's. For many years, the Chinese Communist government opposed Confucianism because the philosophy encouraged people to look to the past rather than to the future. However, government opposition ended in 1977.

See also **Confucius**; **I Ching**; **Mencius**; **Religion** (Confucianism; picture: Confucius' birthday); **Xunzi**.

Confucius (551?-479? B.C.) was the most influential and respected philosopher in Chinese history. From the 100's B.C. to the A.D. 1900's, the ideas of Confucius served as the single strongest influence on Chinese society. These ideas, which are called *Confucianism*, stress the need to develop moral character and responsibility.

Chinese governments made Confucius' teachings the official state philosophy. Millions of people in China—and in such nearby countries as Japan, Korea, and Vietnam—honoured Confucius in much the same way as other peoples honour founders of religions. For details of the philosophy of Confucius, see **Confucianism**.

Confucius was born in the duchy of Lu, in what is now Shandong Province, China. His real name was Kong Qiu. The name *Confucius* is a Latin form of the title *Kongfuzi*, which means *Great Master Kong*. Confucius' parents died when he was a child. He failed in an attempt to become an adviser to a wise ruler. Confucius had wanted the position so he could put into practice his ideas for reforming society. Confucius received some minor official appointments, but at his death he was largely unknown throughout China. His disciples spread his teachings.

No book exists that was definitely written by Confucius. His conversations and sayings were recorded by his disciples in a book called the *Analects* (or *Conversations*).

See also **Religion** (picture: Confucius' birthday)



Confucius

Conga drum is a percussion instrument that is chiefly used in playing Latin-American music. Jazz bands and combos sometimes use the conga drum as a rhythm instrument.

A conga drum is shaped like a slightly rounded cylinder and is made of wood or fibreglass. An animal skin covering called a *head* is stretched tightly across the top of the cylinder. Musicians strike the head with the fingers and the entire hand. They usually play a conga drum sitting down, with the drum held between the knees. They may also play the drum while standing, with the instrument mounted on a stand or suspended by a strap from the shoulder.

There are three different types of conga drum. They are, from highest to lowest pitch, the quinto, the conga, and the tumbadora.

The conga drum developed from an ancient African drum. This drum consisted of a section of a hollow tree trunk with an animal skin stretched across one end.

Congenital defect. See Birth defect.

Congenital disease. See Disease (Congenital diseases).

Congleton (pop. 82,900) is a local government district in Cheshire, England. It contains the former borough of Congleton and the towns of Alsager, Middlewich, and Sandbach. Agriculture, especially dairy farming, is important in the district. Industries include engineering, salt mining, silica sand quarrying, and the production of chemicals, sheets and towels, food products, and commercial motor vehicles.

See also Cheshire.

Conglomerate, in business, is a large corporation that controls or owns a number of companies that generally operate in unrelated markets. A company becomes a conglomerate through *mergers* (combinations of two or more companies) and *takeovers* (when one company takes control of another). Usually, conglomerates maintain the separate identity and management of their different companies.

There are three types of conglomerate mergers: (1) market extension mergers, (2) product extension mergers, and (3) pure conglomerate mergers. Market extension mergers combine companies that sell similar products or services in separate geographic markets, such as an international air carrier acquiring a regional airline. Product extension mergers bring together firms in related markets, such as an oil company buying petrol stations. Pure conglomerate mergers combine firms in unrelated markets, such as an air carrier purchasing a fast-food chain.



The conga drum is popular in Latin-American music. Musicians strike the drum with their fingers and hands. They usually play sitting down, holding one or two drums between their knees.

The conglomerate has been extremely popular with investors since the early 1960s. Conglomerates have developed wide-ranging interests, allowing them to adapt to changes in the marketplace when other companies have not.

Companies often form conglomerates to avoid a disastrous loss. A conglomerate can usually offset temporary losses in some of its companies with the gains of others. Conglomerates also may reduce costs by centralizing production, marketing, financial, and management activities. But critics claim that some conglomerates hurt competition because they can obtain a strong position in a market without adding to the number of firms in that market. Critics also fear that the financial power of some conglomerates can help them dominate markets that were previously composed of many small, single-industry firms.

However, supporters of conglomerates have argued that the financial power of a conglomerate does not guarantee that it can control any market in which the firm sells. Supporters also argue that conglomerates maintain competition by rescuing some weak companies that otherwise might go bankrupt.

Conglomerate. See Rock (Clastic sediments).

Congo is a hot, humid country in west-central Africa. The equator runs through the country. Thick forests of trees and tangled bushes and vines cover the northern half of Congo. Much of this part of the country is inhabited chiefly by animals. The few people who live there travel by dugout canoe.

Congo was once a territory in French Equatorial Africa. It became independent in 1960. Its name in French, the official language, is République du Congo (Republic of Congo). Brazzaville is the country's capital and largest city.

Most of the soil in Congo is poor, but the country has several mineral resources. Congo is a transportation centre. Pointe-Noire, on the Atlantic coast, is an important port. Gabon and the inland countries of the Central African Republic and Chad use Pointe-Noire for some trade.

Government. The president, Congo's most powerful official, is elected by the people to a five-year term. The president appoints a prime minister and Cabinet ministers to carry out day-to-day government operations. Congo's laws are made by a parliament consisting of a National Assembly and a Senate. The 125 members of the National Assembly are elected by the people to five-

Facts in brief about Congo

Capital: Brazzaville.

Official language: French.

Area: 342,000 km². *Greatest distances*—north-south, 950 km; east-west, 829 km. *Coastline*—160 km.

Population: *Estimated 1996 population*—2,662,000; *density*, 8 people per km²; *distribution*, 57 per cent rural, 43 per cent urban. *1985 census*—1,843,421. *Estimated 2001 population*—3,055,000.

Chief products: *Agriculture*—bananas, cassava, coffee, palm kernels and oil, peanuts, plantains, rice, rubber, sugar cane, sweet potatoes, yams. *Forestry*—limba, mahogany, okoumé.

Mining—lead, natural gas, petroleum, potash, zinc.

Money: *Currency unit*—franc. One franc=100 centimes.

year terms. The Senate's 60 members are elected to six-year terms by local government councils.

People. For Congo's total population, see the *Facts in brief* table with this article. Most of the people live either on the southern border near Brazzaville, or on the coast in and around Pointe-Noire.

The people belong to four main groups: (1) the Kongo, (2) the Batéké, (3) the M'Bochi, and (4) the Sangha. Each group includes several subgroups. About 45 per cent of the people belong to the Kongo group, farmers who live west and southwest of Brazzaville. About 20 per cent belong to the Batéké group. They live north of Brazzaville and hunt and fish for a living. About 10 per cent are M'Bochi. Fishing was once the chief means of support for the M'Bochi. Today, however, many of them work as clerks and technicians in the towns. The Sangha live in the northern forests.

About half the people practise *fetish* religions. They believe that all things, even lifeless objects such as stones, have spirits. About 4,500 are Muslims, and most of the rest are Christians.

Most of the older Congolese cannot read or write, but about 75 per cent of the children now receive some elementary education. The Centre of Administrative and Advanced Technical Studies in Brazzaville offers higher education to Congolese and to students from the Central African Republic, Chad, and Gabon.

Land. Congo covers 342,000 square kilometres and six geographical regions. The regions include: (1) the Coastal Plain, (2) the Mayombé Escarpment, (3) the Niari Valley, (4) the Pool Malebo (formerly called Stanley Pool) Region, (5) the Batéké Plateau, and (6) the Congo (Zaire) River Basin.

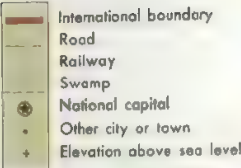
The Coastal Plain extends about 64 kilometres inland from the Atlantic Ocean. The region is generally dry and treeless. There are lagoons near the coast.

The Mayombé Escarpment, and a series of plateaus from 490 to 790 metres above sea level, lie behind the coastal plain. River valleys cut into these forested ridges.

The Niari Valley, a richer farming region, lies beyond the Mayombé Escarpment. It is covered by wooded land and *savannas* (grassy plains).

The Pool Malebo Region, east of the Niari Valley, consists of a series of bare hills. Most of the land there has been cleared for farming. Pool Malebo is a lake

Congo



formed by the widening of the Congo (Zaire) River.

The Batéké Plateau is a grass covered elevated plain in central Congo. Deep, forested valleys containing tributaries of the Congo (Zaire) River divide the plateau.

The Congo (Zaire) River Basin in the north includes large swampy areas. The Ubangi, the main Congo tributary, forms the country's northeastern border



Brazzaville, the capital and largest city of Congo, is also a commercial centre. The city lies on the Congo (Zaire) River.

Most of Congo is hot and humid, with rainfall throughout the year. Parts of the Congo (Zaire) River Basin have about 250 centimetres of rainfall a year, and temperatures average from 24° to 26° C. The Batéké Plateau averages less than 150 centimetres of rain a year. Temperatures there vary from 21° to 27° C. The coastal area is cooler and drier because the cold Benguela ocean current flows along the coast.

Economy. Except for its forests and some minerals, Congo has few natural resources. It also has few industries. There is a high rate of unemployment.

Most of the Congolese raise bananas, maize, rice, and other crops to feed their own families. Petroleum is the country's most valuable mineral. Other minerals include lead, natural gas, potash, and zinc. Lumber and petroleum are the chief exports. Most of the lumber comes from the Mayombé ridges and the northern forests. Oil deposits are found in the vicinity of Pointe-Noire.

Congo has one of the longest transportation systems in Africa. The Congo-Ocean railroad, a 515-kilometre line linking Brazzaville and Pointe-Noire, and its branch line form the only railway. Barges use the Congo (Zaire) and Ubangi rivers north of Pool Malebo at Brazzaville, but rapids below Pool Malebo prevent barges from getting to or from the ocean. The Congo-Ubangi river system carries goods and passengers as far as Bangui, capital of the Central African Republic, a distance of 1,100 kilometres. Most of the exports and imports of the Central African Republic and Chad move over the river system and the Congo-Ocean railway. Gabon's manganese ore moves over the branch of the railway. This shipping trade is important to the Congo economy. Building and maintaining roads is difficult because of heavy rains and thick forests.

History. A small part of what is now Congo probably was part of the Kongo kingdom, which flourished during the 1400's and 1500's (see *Kongo*). Portuguese explorers reached the Congo coast in the 1400's. Portuguese and other European traders bought slaves and ivory along the coast from the late 1400's to the 1800's. But Europeans did not explore the interior of what is now Congo until the late 1800's. Pierre Savorgnan de Brazza, a French explorer, reached the area in 1875. Henry Morton Stanley, the famed British explorer, sailed down the Congo River from its source to the ocean in 1876 and 1877 (see *Stanley and Livingstone*).

In 1880, Brazza and Makoko, the Bateké king, signed a treaty that placed the area north of the Congo (Zaire) River under French protection. This area, then called Middle Congo, became a territory in French Equatorial Africa in 1903. In 1910, it was linked with the territories of Gabon, Chad, and Ubangi-Shari (now the Central African Republic). Middle Congo gained internal self-government in 1958, and independence on Aug. 15, 1960.

Fulbert Youlou became the first president, but the army and trade unions forced him to resign in 1963. A socialist government then took control, and Alphonse Massamba-Débat became president. In 1964, the government made Congo a one-party state. It took control of industries and recognized such Communist governments as those of China, North Korea, and North Vietnam. In 1968, military officers led by Major Marien Ngouabi removed Massamba-Débat from office and set

up a temporary government. In 1970, a new constitution was adopted. Ngouabi became president of the country.

In 1977, Ngouabi was assassinated. An 11-member military council took control of the government. The council named Colonel Joachim Yhombi Opango president. It accused former President Massamba-Débat of plotting Ngouabi's assassination. Massamba-Débat was convicted and executed. In 1979, the military council was abolished and Colonel Denis Sassou-Nguesso replaced Opango as president.

In 1989, the government began to reduce state ownership of industries. In 1991, opposition political parties were legalized. In 1992, voters approved a new constitution. Elections were held in 1992. The Pan-African Union for Social Democracy (UPADS) won the most seats in both houses of parliament. Pascal Lissouba, of the UPADS, was elected president.

See also *Brazzaville; Congo River*.

Congo (Kinshasa). See *Zaire*.

Congo River, also called the Zaire River, is the fifth longest river in the world. It begins south of Kabalo, Zaire, where the Lualaba and the Luvua rivers meet. From this point until Boyoma Falls (formerly called Stanley Falls), the river is often called the Lualaba. After Boyoma Falls, it is the Congo. In Zaire, it is known as the Zaire River. The Congo (Zaire) River flows 4,667 kilometres through west-central Africa. It carries more water than any other river except the Amazon. The river drains an area of about 3,630,000 square kilometres.

Near Boyoma Falls, the river turns westward and flows across northern Zaire. Several major rivers, including the Aruwimi, Lomami, and Ubangi, empty into the Congo. Near Mbandaka, Zaire, the Congo turns southward. It then forms the border between Zaire and the country Congo for about 800 kilometres. The Kasai River joins the Congo about 480 kilometres southwest of Mbandaka. Near Kinshasa, Zaire, the Congo widens, creating a lake called Pool Malebo (formerly called Stanley Pool). The river then drops about 240 metres as it forms a series of 30 waterfalls between Kinshasa and Matadi, Zaire. The Congo empties into the Atlantic Ocean about 140 kilometres west of Matadi.

Unlike the Mississippi and the Nile, the Congo (Zaire) River has no delta. The Congo's muddy waters flow into



Location of the Congo (Zaire) River

a deep trench that extends far into the Atlantic Ocean.

The Congo is the main waterway of Zaire. Commercial ships use the river between the Atlantic and Matadi and between Kinshasa and Kisangani. The river serves as a major transportation route for Zairians, especially in areas that have few good roads. Rapids prevent navigation in some parts of the upper Congo.

In 1483, the Portuguese navigator Diogo Cão became the first European to reach the mouth of the Congo. Portuguese settlers established an outpost on the southern shore of the river near the Atlantic Ocean in the 1490's. But Europeans knew little about the rest of the river until after the British explorer Sir Henry Morton Stanley completed an expedition from its source to its mouth in 1877.

See also **Stanley and Livingstone**; **Zaire** (picture: The Congo (Zaire) River).

Congregationalists are members of a Protestant religious group. Congregationalists believe that all Christians have direct access to God through Christ, and, as a result, are equal. Unlike many other Christian denominations, Congregationalists reject outside control by bishops and councils. They believe that each congregation should control its own affairs, including the selection of ministers.

The minister is responsible for conducting public worship, administering the sacraments, teaching, and the pastoral care of the church. But the minister shares these tasks with all church members, and, as a rule, any function performed by a minister may be performed by a nonordained church member.

Beliefs and Worship. In matters of faith, Congregationalists base their beliefs on the Bible. They accept no creed or doctrinal statement as binding.

In worship, Congregationalists use simple forms of service without a formal liturgy (see **Liturgy**). The services consist mainly of prayers, Bible readings, hymns, and a sermon. They observe infant and adult baptism, and the sacrament of the Lord's Supper. In the sacrament of the Lord's Supper, they stress the element of communion, rather than the aspect of sacrifice (see **Communion**).

History. Congregationalism began in its present form at the Reformation in the 1500s. The first leaders of the Congregational movement were English. They included Robert Browne, Robert Harrison, and Henry Church. The Congregationalists objected to certain ceremonies in the Church of England, opposed the idea of a national church, and desired a more radical reformation.

When the authorities persecuted them, some Congregationalists emigrated to the mainland of Europe. In 1620, others sailed to North America in the *Mayflower*. Later, many more Congregationalists settled in North America, and worked to establish a government where state and Church would be one. Congregationalist doctrines had a lasting influence on religious and cultural life in the United States. Congregationalists in the United States founded Harvard University in 1636, and Yale University in 1701.

Congregationalists had some political power during the Commonwealth and Protectorate in England from 1649 to 1659. When the monarchy was restored in 1660, they were persecuted again. Later, the Toleration Act of 1689 allowed them freedom of worship. Congregational-

ists were excluded because of their religious beliefs from most British universities and some civil posts until 1828.

Congregationalists founded the London Missionary Society in 1795. It remained the main missionary body of Congregationalism until 1964, when all Congregational missionary societies were combined.

Congregational churches can be found worldwide. In many countries, Congregational churches have merged with denominations of a similar outlook to form united churches.

Congress comes from the Latin word *congressus*, which means a *meeting*. Any group of people who represent organizations, regions, or nations, and who meet together to discuss their problems, may be called a congress. An *international congress* is a conference attended by representatives of various nations. In the United States, the word *congress* usually refers to the Congress of the United States. The name *congress* was given to several important international conferences which took place in the 1800's to determine boundaries and arrange political settlements in Europe. The most important of the congresses were as follows:

Congress of Vienna (1814-1815), which divided up Napoleon's empire after the Napoleonic Wars.

Congress of Paris (1856), which settled the problems that grew out of the Crimean War. This congress also was an important step in the growing unity of Italy.

Congress of Berlin (1878), which took away from Russia Balkan land it had won from Turkey during the Russo-Turkish Wars.

See also **Berlin, Congress of**; **Continental Congress**; **Vienna, Congress of**.

Congress of the United States makes the nation's laws. Congress consists of two bodies, the *Senate* and the *House of Representatives*. Both bodies have about equal power. The people elect the members of Congress.

Although Congress's most important task is making laws, it also has other major duties. For example, the Senate approves or rejects the U.S. President's choices for the heads of government departments and certain other high-ranking jobs. The Senate also approves or rejects treaties that the President makes.

Each member of Congress represents many citizens. Therefore, members must know the views of the voters and be guided by those views when considering proposed laws. Being a member of Congress also means answering citizens' letters, appearing at local events, and having local offices to handle people's problems with the government.

How Congress is organized

Congress is a *bicameral* (two-chamber) legislature. The 100-member Senate consists of 2 senators from each of the 50 states. The House of Representatives has 435 members. Members, or *representatives*, are elected from *congressional districts* of about equal population into which the states are divided. Every state must have at least one seat in the House of Representatives.

The Democratic and Republican parties have long been the only major political parties in Congress. In each house of Congress, the party with more members is the *majority party*. The other one is the *minority party*.



Congress, the lawmaking branch of the United States government, consists of the Senate and the House of Representatives. During joint sessions, above, all members meet in the House chamber.

Committees form an important feature of each chamber's organization. They prepare the bills to be voted on. The committee system divides the work of processing legislation and enables members to specialize in particular types of issues. The majority party in each chamber elects the head of each committee and holds a majority of the seats on most committees.

The Senate. According to the Constitution, the Vice President of the United States serves as head of the Senate with the title *president of the Senate*. However, the Vice President is not considered a member of that body and, except on ceremonial occasions or to break a tie vote, rarely appears there. The Senate elects a *president pro tempore* (temporary president) to serve in the Vice President's absence. The Senate usually elects the majority party senator with the longest continuous service. The president pro tempore signs official papers for the Senate but presides infrequently. Most of the time, the president pro tempore appoints a junior senator as temporary president.

Democrats and Republicans each elect a chief officer called a *floor leader*, also known as the *majority leader* or the *minority leader*, depending on the senator's party. Each party elects an officer called a *whip* to assist the floor leaders. They arrange the Senate's schedule, work for passage of their party's legislative programme, and look after the interests of absent senators.

The House of Representatives. The *Speaker of the House* serves as presiding officer and party leader. The majority party nominates the Speaker, who is then elected by a party-line vote of the entire House. The Speaker is the most important member of Congress because of the office's broad powers. The Speaker refers bills to committees, names members of special committees, and nominates the majority party's members of the powerful Rules Committee. In addition, the Speaker votes in case of ties and grants fellow representatives the right to speak during debates. As in the Senate, the

House majority and minority parties each choose a floor leader and a whip.

When Congress meets. A new Congress is organized every two years, after congressional elections in November of even-numbered years. Voters elect all the representatives, resulting in a new House of Representatives. About a third of the senators come up for election every two years. The Senate is a *continuing body* because it is never completely new.

Congress holds one regular session a year. The session begins on January 3 unless Congress sets a different date. During the year, Congress recesses often so members can visit their home states or districts. Congress adjourns in early autumn in election years and in late autumn in other years. After Congress adjourns, the President may call a *special session*. The President may adjourn Congress only if the two houses disagree on an adjournment date. The Senate and the House meet in separate chambers in the Capitol in Washington, D.C.

How Congress makes laws

Congress passes and the President signs about 650 laws during every two-year Congress. During that period, senators and representatives introduce about 10,000 bills. The legislative process suits the proposals at every stage in the development of a bill to a law. To be enacted, a bill must survive committee and floor debates in both houses. A bill must also gain a majority of votes in Congress and the President's signature. If the President vetoes the bill, it needs overwhelming support in Congress to override the veto.

Proposing new laws. Laws can be proposed by anyone, including lawmakers or their staffs, executive officials, or special-interest groups. But to become a law, a bill must be sponsored and formally introduced in Congress by a member.

A bill may be *public* or *private*. A public bill deals with matters of concern to people in general. Such mat-

ters include taxation, national defence, and foreign affairs. A private bill applies only to specific individuals, as in an immigration case or a claim against the government. To become a law, either kind of bill must be passed in exactly the same form by both houses of Congress and then signed by the President.

Working in committees. After being introduced, a bill goes to a committee that deals with the matters the bill covers. Some bills involve various subjects and may be handled by several committees. The chief congressional committees are the 16 Senate and the 22 House standing committees. They handle most major fields of legislation, such as agriculture, banking, foreign policy, and transportation.

A proposed law reaches a critical stage after being referred to a committee. Committees *report* (return) only about 15 per cent of all bills they receive to the full Senate or House for consideration. Most bills are *tabled*, or *pigeonholed*—that is, never acted on. A committee's failure to act on a bill almost always spells death for the measure.

If committee leaders decide to proceed with a bill, they usually hold public hearings to receive testimony for and against the proposal. Testimony may be heard from a range of people, such as members of the President's Cabinet, scholars, representatives of special-interest groups, or lawmakers themselves.

Some bills go from committee to the full House or Senate without change. But most bills must be revised in committee *markup* sessions. In a markup session, members debate the sections of a measure and write amendments, thereby "marking up" the bill. When a majority of the committee's members vote for the revised bill, they report it to the full chamber with the recommendation that it be passed.

Passing a bill. Committees screen out bills that lack broad support. Therefore, most measures that reach the House or Senate floor for debate and voting eventually pass. Senators usually call a bill up for consideration by a simple motion or by *unanimous consent*—that is, without anyone's objection. The objection of one senator can block unanimous consent, and so Senate leaders work to make sure the bill is acceptable to their associates.

The House considers most bills by unanimous consent, like the Senate, or by the *suspension-of-rules procedure*. Both methods speed up legislation on largely uncontroversial bills. Representatives consider controversial bills under rules made by the Rules Committee. The rules control debate on a bill by setting time limits, restricting amendments, and, occasionally, barring objections to sections of the bill. Debate time is divided between the bill's supporters and opponents.

Legislators use various methods to vote on a bill. In a *voice vote*, all in favour say aye together, and those opposed say no. In *division*, the members stand as a group to indicate if they are for or against a bill. In a *roll-call vote*, the lawmakers each vote yes or no after their name is called. The House usually records and counts votes electronically. Members vote by pushing a button.

Senators and representatives tend to vote according to their party's position on a bill. If legislators know the views of their *constituents*—that is, of the people who elected them—they may vote accordingly. The President and powerful lobbies also influence how members vote.

From bill to law. After a bill passes one house of Congress, it goes to the other. The second house approves many bills without change. Some bills go back to the first house for further action. Once the two chambers have approved the bill, it is sent to the President.

The President has 10 days—not including Sundays—to sign or veto a bill after receiving it. The veto is most powerful when used as a threat—lawmakers working on a bill want to know if the President is likely to approve it. If the President fails to sign or return the bill within 10 days and Congress is in session, the bill becomes law. But if Congress adjourns during that time, the bill does not become law. Such action is called a *pocket veto*.

History of Congress

The founding of Congress grew out of a tradition of representative assemblies that was brought from Great Britain and took root in the American Colonies in the early 1600's. Colonial assemblies had a wide range of powers, including authority to collect taxes, issue money, and provide for defence. In time, the assemblies increasingly voiced the colonists' interests against those of the British-appointed colonial governors.

As tensions worsened between Great Britain and the American Colonies in the 1760's, the colonial assemblies took up the colonists' cause. The First Continental Congress, which met in Philadelphia in 1774, could be considered the country's first national legislature. In 1776, the Second Continental Congress declared the colonies independence from Britain. The Second Continental Congress served as the national government until 1781 when the states adopted the Articles of Confederation and established the Congress of the Confederation. The Congress of the Confederation functioned without an independent executive or judicial branch and soon showed its weakness.

In 1787, delegates to the Constitutional Convention drew up a new plan of government—the Constitution of the United States. The power of the legislature remained important, but it was balanced by executive and judicial branches. The Constitution called for two chambers for the new Congress—earlier Congresses had one house—with equal representation in one chamber (the Senate) and representation by population in the other (the House of Representatives). The establishment of a two-house legislature solved a bitter dispute between delegates from small states, who favoured equal representation for every state, and those from large states, who wanted representation based on state population.

Related articles in *World Book* include:

Articles of Confederation	Library of Congress
Continental Congress	Lobbying
Electoral College	President of the United States
House of Representatives	Senate
Impeachment	

Congreve, Richard (1818-1899), was a British essayist. He founded the British branch of a system of philosophy called *Positivism*, originated by Auguste Comte (see *Comte, Auguste*). Congreve regarded Positivism as both a philosophy and a religion. His works include *Essays, Political, Social and Religious* (1874); *Elizabeth of England* (1862); and a translation of Comte's *The Catechism of the Positive Religion* (1858). Congreve was born at Leamington, in Warwickshire, England.

Congreve, William (1670-1729), was an English dramatist who wrote witty, sophisticated comedies. The best of his five plays are *Love for Love* (1695) and *The Way of the World* (1700). They contain lively and clever speeches rather than memorable characters or comic situations. They have a polished prose style and a civilized, realistic view of life. *The Way of the World* presents a satirical picture of a cultured, worldly, high society. The play laughs at hypocrites, bores, would-be wits, fools, and aging coquettes. Congreve's most popular play during his lifetime was *The Mourning Bride* (1697), his only tragedy. It contains the famous line "Music has charms to soothe a savage breast."

Congreve was born in Yorkshire, England, and grew up in Ireland. He entered law school in London in 1691, but preferred writing and the leisurely life of a man about town. He wrote little after 1700.

Congreve, Sir William (1772-1828), a British inventor developed rockets that could carry explosives. His work, which included a book on rocketry, promoted the use of rockets as a major military weapon. The British used Congreve rockets against French troops during the Napoleonic Wars (1793-1815). British forces also bombarded Fort McHenry in Baltimore, Maryland, U.S.A. with such rockets during the War of 1812. See **Rocket** (Early rockets).

Congreve was born in Woolwich, now part of Greater London, and received a degree from Cambridge University in 1795. He succeeded to his father's baronet title in 1814. Congreve received 18 patents. He devised new methods of mounting naval guns and manufacturing gunpowder. He also invented a steam engine, a sprinker system, and various other devices.

Conic projection. See **Map**.

Conifer is any one of a large group of trees or shrubs that bears its seeds in cones. Most conifers have tall, straight trunks and narrow branches and grow in cold or cool climates. Common conifers include cedars, cypresses, firs, hemlocks, junipers, larches, pines, redwoods, sequoias, and yews. Araucarias and kauris are conifers from the Southern Hemisphere. The cycad plant also bears cones, but it is not considered to be a conifer (see **Cycad**).

Conifers are one of the oldest groups of woody



A conifer plantation of Monterey pines, in New Zealand, rises above an undergrowth of mamaku tree ferns

plants. Conifer fossils have been found in rocks that are about 300 million years old. Conifers include the largest tallest, and oldest living things. The largest giant sequoia is about 84 metres high, and the base of its trunk has a circumference of 31.5 metres. Redwoods, the tallest living trees, may tower more than 110 metres high. Some bristlecone pines are more than 4,600 years old.

Conifers form about 30 per cent of the world's forests. Most of the wood used in houses and other buildings comes from conifers, especially Douglas-fir and loblolly pine. Conifers also provide much wood pulp for making paper and cardboard. In addition, millions of conifers are used every year as Christmas trees.

Most conifers are evergreen and have small, needle-like leaves. Conifers are sometimes called *needleleaf trees*. Other conifers, including redcedars and cypresses, have tiny, scalelike leaves that cling to the stem. These trees are also evergreen. Larches and bald cypresses are conifers that lose their leaves every year.

Conifer cones range from less than 12 millimetres long to more than 60 centimetres long. Conifers have two types of cones—male and female. In most conifers, both types grow on the same plant. The soft male cones produce and release pollen, then shrivel and die. The female cones are larger and become woody with age. Each of their scales has two structures called *ovules*, which contain *eggs* (female reproductive cells). Wind carries pollen from the male cones to the female cones, where the pollen fertilizes the egg. The ovules then develop into seeds. After the seeds become fully formed, they fall from the cones.

A few conifers have unusual, fleshy cones. Juniper seed cones resemble blueberries. Yew seed cones look like red berries with a single, large seed.



The leaves of conifers may be scalelike or needlelike. The scalelike leaves of the northern white cedar, left, cling to the stem. The needlelike leaves of the red spruce, right, grow out from the stem. The cones also differ in appearance.

Scientific classification. Conifers make up the division Coniferophyta in the plant kingdom, Plantae. There are several families and many genera in this division.

Related articles in *World Book* include:

Arbovitae	Fir	Piñon
Bald cypress	Ginkgo	Plant (pictures)
Balsam fir	Gymnosperm	Redwood
Bristlecone pine	Hemlock	Sequoia
Cedar	Juniper	Spruce
Cycad	Kauri	Tree (Needleleaf trees; pictures)
Cypress	Larch	Yew
Douglas-fir	Monkey-puzzle tree	
Evergreen	Pine	

Conjoined twins. See Siamese twins.

Conjugation, in biology. See Paramecium.

Conjugation is a complete list of the forms of a verb by mood, number, person, tense, and voice. A *synopsis* is a summary of these forms in only one person, as shown below for the verb *show*.

Each verb form expresses a different shade of meaning. Progressive forms indicate an action in progress at any particular time ("The first film *was showing* when we arrived"). Emphatic forms may add a degree of emphasis, but they are used primarily to form questions ("Does it *show?*") and negative statements ("It *does not show?*"). The imperative mood gives commands ("Show what it is like"). The subjunctive mood expresses urgency ("The people insisted that the film *be shown?*"); wishing ("I wish it *were being shown* now"); or reflects a condition con-

trary to fact ("If the film *were shown*, we would be in trouble").

See also Mood; Number; Person; Tense; Verb; Voice.

Conjunction is a word used to connect words, phrases, clauses, and sentences. The term comes from two Latin words that mean *joined with*. There are two kinds of conjunctions, *coordinating* and *subordinating*.

Coordinating conjunctions connect grammatically equal words, phrases, clauses, or sentences as in the following examples. Words—"He ate bread *and* butter." Phrases—"In red coats *and* with loud drums, the soldiers came marching." Clauses or sentences—"He reads well, *but* his sister reads better."

The principal coordinating conjunctions are:

Expressing addition: and, also, both, as well as, further, likewise.

Expressing separation or choice: either, or, neither, nor, else, whether, otherwise.

Expressing opposition: but, yet, still, only, whereas.

Conjunctions in pairs, as in the following examples, are called *correlative conjunctions*.

Both . . . and: Both John *and* Mary attend school.

Not only . . . but also: He *not only* reads *but also* writes.

Either . . . or: Either I must go now *or* I can never go.

Neither . . . nor: Neither the child *nor* the man went.

Whether . . . or: Whether it rains *or* shines, I will go.

Subordinating conjunctions join a subordinate clause to the principal clause of a sentence—elements that are not grammatically equal. "He can read better *than* I can." *Than* is a subordinating conjunction connecting the subordinate clause *I can (read is understood)* with the principal clause.

The commonest subordinating conjunctions are:

Expressing time and place: when, as, since, while, before, ere, after, until, where.

Expressing cause or reason: because, since, as, whereas, inasmuch as, for.

Expressing condition or supposition: if, unless, though, although, provided, in case, even if.

Expressing purpose or result: that, so that, lest, in order that, so . . . as.

Expressing comparison: than (after comparative), as . . . as, so . . . as.

Conjunctivitis is an inflammation of the membrane that covers the white part of the eyeball and the inner lining of the eyelid. This membrane is called the *conjunctiva*. Conjunctivitis may be caused by infections of bacteria, viruses, or other microorganisms. It also may result from allergies or chemical burns. Most types of conjunctivitis caused by infection are contagious.

Symptoms of conjunctivitis include burning, itching, watering and redness of the eye, and the sensation that an object is lodged on the eyeball. In addition, pus may form and the eyelids may stick together.

Acute conjunctivitis, or *pinkeye*, is often caused by bacteria. In most cases, doctors can cure bacterial conjunctivitis within a few days by applying antibiotics. Most cases of viral conjunctivitis usually do not respond to drugs but many types rapidly clear up by themselves. However, some types of viral conjunctivitis may last a long time and infect the *cornea*, the clear tissue at the front of the eye. When this occurs, the person's vision

Indicative mood

Simple forms

Tense	Active voice	Passive voice
Present	it shows	it is shown
Past	it showed	it was shown
Future	it will show	it will be shown
Present perfect	it has shown	it has been shown
Past perfect	it had shown	it had been shown
Future perfect	it will have shown	it will have been shown

Progressive forms

Tense	Active voice	Passive voice
Present	it is showing	it is being shown
Past	it was showing	it was being shown
Future	it will be showing	"
Present perfect	it has been showing	"
Past perfect	it had been showing	"
Future perfect	it will have been showing	"

*No commonly accepted usage in this voice

Emphatic forms

Tense	Active voice only
Present	it does show
Past	it did show

Imperative mood

Used only in the second person, present tense

Active voice	Passive voice
(you) show	(you) be shown

Subjunctive mood

Tense	Active voice	Passive voice
Present	(if) it show	(if) it be shown
Past	(if) it showed	(if) it were shown
Future	(if) it will show	(if) it will be shown
Present perfect	(if) it has shown	(if) it has been shown
Past perfect	(if) it had shown	(if) it had been shown
Future perfect	(if) it will have shown	(if) it will have been shown

may suffer. Allergic conjunctivitis is frequently associated with hay fever. Cold compresses and medicated eyedrops help relieve the symptoms of allergic conjunctivitis. Conjunctivitis caused by exposure to chemicals can result in serious eye damage. In many cases, such damage can be minimized by immediately flushing the eye with water.

Conjuring. See Magician.

Connacht is one of the four provinces of Ireland. It is in the west of the Republic of Ireland and is the most remote of the provinces. It developed more slowly than other parts of the country and has a long history of emigration. Farming has always been important, but toward the end of the 1900's manufacturing and service industries underwent great expansion in the region.

Much of Connacht is very beautiful and attracts large numbers of tourists. The westernmost third of Galway, the region known as Connemara, is famous for its beautiful scenery, and also for its horses. Connacht consists of the five counties of Galway, Leitrim, Mayo, Roscommon, and Sligo. The largest city is Galway.

People and government. The population of Connacht in 1986 was 1 per cent higher than that recorded at the previous census in 1981. Apart from a period of growth in the 1970's, the number of Connacht's inhabitants has generally declined throughout the 1900's. The population now is only two-thirds of what it was in 1900 and less than one-third of the total in 1840. About three-fourths of the population live in rural areas.

Some 96 per cent of the population of Connacht are Roman Catholics. Most of the remainder belong to the Church of Ireland, with a few Methodists and Presbyterians. There are eight Roman Catholic dioceses, most of them belonging to the archdiocese of Tuam. Much of Connacht is in the Church of Ireland united diocese of Tuam, Killala, and Achonry.

Irish customs and traditions have generally survived longer in Connacht than elsewhere in the country. Many people use the Irish language in everyday speech in the Gaeltacht areas. These occupy large parts of west Galway and west Mayo. Elsewhere, English is the everyday language. Gaelic football is the most popular sport, and hurling is also popular in Galway.

Connacht contains six parliamentary constituencies. These elect 21 members to Dail Eireann (the lower house of the Irish parliament). Local government is run by five county councils, the county borough corporation of Galway, and the borough corporation of Sligo.

Economy. More than one-fourth of the working people of Connacht have jobs in farming. Most farms are small. Mountains and peat bogs unsuited to agriculture

Facts in brief about Connacht

Population: 1991 census—422 949

Area: 17,121 km²

Counties: Galway, Leitrim, Mayo, Roscommon, Sligo.

County borough: Galway

Largest towns: Galway, Sligo, Ballina, Castlebar, Ballinasloe, Tuam

Chief products: Agriculture—cattle, milk, sheep. Other primary products—fish, marble, peat, sand and gravel, stone, timber. Manufacturing—clothing, electrical and electronic equipment, furniture, household appliances, meat products, medical supplies, plastic goods, pottery and glassware, printed matter, synthetic fibres.



Galway Industrial Estate has encouraged new industries and has brought prosperity to many of Connacht's people.

occupy one-third of the province. Much of the farmland is not fertile, except in the east. It is used mainly for growing grass for livestock. Beef cattle production is the principal type of farming in all counties, but there is some dairying. There are many sheep in the uplands and on the lowlands of the southeast. Only 3 per cent of farmland is used to grow arable crops. The main crops are barley, oats, and potatoes.

There are modern factories in many towns throughout Connacht. Galway is the main industrial centre, and Sligo also has many factories. A wide range of manufactured goods is produced in Connacht, but the most common type of modern industry is light engineering. Other industries include chemicals, food processing, printing, textile and clothing manufacture, and wood products.



Connacht, a province in Ireland, lies to the west of the River Shannon.



Modern Industries in Connacht include the production of refrigeration units that can be fitted to trucks.

Nearly half of the people of Connacht work in service industries. The main types are retailing, education, health services, public administration, and transport. There is a university college in Galway and regional technical colleges in Galway and Sligo.

Tourism is an important source of income, especially in coastal areas. Salthill, a seaside suburb of Galway, is the main resort. Angling on rivers and lakes also attracts many visitors.

Fishing is important in several coastal districts, especially in County Galway. Many people combine fishing with farming as a means of earning a living. The area of forestry has increased greatly, much of it in upland and peat bog areas. There is extensive peat cutting. Marble is quarried in County Galway.

Transport in Connacht is mainly by road. The principal routes are those running eastward toward Dublin from Sligo (the N4), Castlebar (N5), and Galway (N6). A national primary route, the N17, also runs from north to south through Connacht. In some areas there are no roads because of mountains and peat bogs. Railways run to Dublin from Galway, from Westport and Ballina, and from Sligo.

Galway is the main seaport. Horan International Airport is near Knock, in County Mayo. There are smaller airports near Galway, Sligo, and Castlebar, and sea and air services to the Aran Islands.

Land. Most of Connacht lies to the west of the River Shannon. To the east is Leinster, to the south is Munster, and to the north is Ulster. The western limit is the long and *indented* (jagged) Atlantic coastline. Offshore islands include the Aran Islands and Achill Island. Connacht occupies one-fourth of the Republic of Ireland. It measures about 140 kilometres from north to south and about 160 kilometres from east to west.

Extensive areas of mountains and peat bogs lie in the west of Connacht, and there are similar areas in the north. These are the most attractive parts of the province. Much of the remainder lies in the central lowland of Ireland, where the underlying rock is limestone. Water in the eastern part of the province drains to the River Shannon and its three lakes: Loughs Allen, Ree, and Derg. The principal drainage basins in the west are

those of the rivers Corrib and Moy. Loughs Corrib, Mask, and Conn lie along the edge of the western uplands.

The climate of Connacht is mild and moist, with winds blowing in from the Atlantic Ocean. The average temperature in July is about 15° C, but in January it varies from about 4.5° C in the northeast to over 6° C along the west coast. Annual rainfall rises from 100 centimetres in the lowland east to more than 200 centimetres on the mountains of the west. Even on the lowlands, rain falls on between 170 and 200 days each year.

History. People have settled in Connacht since Stone Age times. Ancient monuments are especially common in Sligo and north Mayo. Connacht was one of the ancient kingdoms of Ireland. One of its most famous legendary rulers was Queen Maeve. Celtic monks founded monasteries from the 400's, and monks from Europe also built monasteries from the 1100's. The Connacht rulers Turlough O'Connor and his son Rory were recognized as kings of Ireland during the 1100's.

After the Anglo-Norman invasion of the 1200's, much of Connacht was ruled by Richard de Burgo. The earliest towns were founded at this time. Connacht long remained one of the most Gaelic areas in Ireland. In the 1600's, it became a refuge for homeless persons from other parts of the country. It suffered more than other parts of Ireland during the Great Famine of 1845-1847. In 1879, some children in the tiny village of Knock claimed to have seen visions of the Virgin Mary. Since then Knock has become a place of pilgrimage for Roman Catholics from all over the world.

See also **Galway; Leitrim; Mayo; Roscommon; Sligo.** **Connecticut** is a state in the northeastern United States. It lies in the country's scenic New England region. Bridgeport is Connecticut's largest city. Hartford, the state capital, is a centre of the U.S. insurance industry. (See **Hartford**.)

Connecticut is sometimes called the *Constitution State*. An early Connecticut law, the *Fundamental Orders*, was one of the models for the U.S. Constitution. Connecticut delegates played an active role at the Constitutional Convention of 1787, when the Constitution of the United States was drawn up and signed.

Land. The Eastern New England Upland covers most of eastern Connecticut. The area is heavily forested and



Connecticut, the third smallest state of the United States, lies in the New England region of the northeastern United States

has narrow river valleys and low hills. The Connecticut Valley Lowland is in the centre of the state. The ridges and hills of the Western New England Upland cover most of western Connecticut. The *Taconic Section*, a mountainous region, covers the northwestern tip of the state.

Connecticut's southern shoreline makes up the Coastal Lowlands. Several small islands lie off the coast. The Connecticut River cuts through the centre of the state, providing passage between the Atlantic Ocean and Hartford.

Economy. Service industries account for most of the value of Connecticut's economic output. The state's most valuable industries are finance, insurance, and the buying and selling of property. The Hartford area is the home of several of the largest insurance firms in the United States. Other activities in the service industries that employ many Connecticut workers include education, health care, and retail trade. Yale University in New Haven is one of the leading universities in the United States.

Thousands of Connecticut residents work in the New York City area. Many of them hold professional, service, and business positions that pay well. Most financial occupations within Connecticut also pay well. As a result,

Facts in brief

Population: 3,295,669

Area: 12,997 km²

Climate: Average July temperature 22° C. Average January temperature -3° C.

Elevation: *Highest*—South slope of Mount Frissell 725 m. *Lowest*—Sea level along Long Island Sound shore

Largest cities: Bridgeport, Hartford, New Haven

Chief products: *Agriculture*—eggs, milk, greenhouse and nursery products. *Manufacturing*—transportation equipment, machinery, electrical equipment, fabricated metal products, chemicals, scientific instruments, printed materials. *Mining*—crushed stone

Origin of name: Algonquian Indian word meaning *on the long tidal river*.

Nickname: Constitution State

Statehood: January 9, 1788, the 5th state

the average annual income in Connecticut is higher than in any other U.S. state.

Connecticut is an important manufacturer of military equipment, including aircraft parts, helicopters, and submarines.

History. Algonquian Indian tribes lived in the Connecticut region before the Europeans arrived. Dutch explorers sailed up the Connecticut River in 1614. The first permanent European settlers in the area were English colonists from Massachusetts. They formed the Connecticut Colony in 1636 and adopted the *Fundamental Orders* in 1639. The Orders, sometimes referred to as the first written constitution, gave voters the right to elect government officials. In 1637, the colonists defeated the Pequot Indians, the most powerful tribe in the region. The colony received a charter from England in 1662.

At the U.S. Constitutional Convention of 1787, Connecticut delegates helped work out the *Connecticut Compromise*, or *Great Compromise*. It helped determine how states should be represented in the nation's congress. Connecticut became a state of the U.S.A. in 1788.

During the 1800's, improved transportation and the development of mass production made Connecticut a thriving industrial centre. In 1910, the U.S. Coast Guard made its home in New London. In 1917, the U.S. Navy opened a submarine base in Groton. The world's first nuclear-powered submarine was built and launched there in 1954.

See also **Hartford**.

Connective tissue connects body organs and tissues, holds organs in place, and supports the body. Compared with other types of tissue, connective tissue has relatively few cells and much *intercellular substance* (material outside the cells). Scientists divide connective tissue into three groups, according to the hardness of the intercellular substance. These groups are (1) *soft connective tissue proper*, (2) *firm cartilage*, and (3) *hard bone*. This article discusses connective tissue proper. For information on the other kinds of connective tissue, see the *World Book* articles on **Bone and Cartilage**.

There are two chief types of connective tissue proper—*loose* and *dense*. Loose connective tissue forms the networks of thin fibres that surround such organs as the heart and lungs. It is also found under the skin and over the muscles. Dense connective tissue has more fibres



Many tourists visit Connecticut to enjoy the state's scenic countryside and explore its historic sites

and greater strength than does loose connective tissue. It forms tough capsulelike coverings that keep such organs as the kidneys in place. Dense connective tissue also forms the *ligaments*, which hold the bones and joints in place, and the *tendons*, which connect the muscles to the bones (see **Ligament**; **Tendon**).

In addition, connective tissue proper stores fat cells. Specialized kinds of this tissue called *reticular tissue* manufacture red and white blood cells.

The intercellular substance of connective tissue proper consists of long fibres mixed with a *gelatinous* (jellylike) material. The fibres may be either white or yellow. White fibres, which outnumber the yellow ones in most connective tissue, are made of a protein called *collagen*. Most white fibres resemble strong cords. Some white fibres form strands of delicate reticular tissue. The yellow fibres are made of a protein called *elastin*, which stretches easily.

Connell, Desmond (1926-), became the Roman Catholic archbishop of Dublin and primate of Ireland in 1988. For the previous 35 years he had taught metaphysics at University College, Dublin, and was professor there from 1972 to 1988. Connell was born in Dublin. His education included study at University College; St Patrick's College, Maynooth; and Louvain University, Belgium. He was chaplain to several orders of nuns between 1953 and 1988. He published a book, *The Vision in God*, in 1967.

Connemara. See **Connacht**.

Connolly, James (1870-1916), was an Irish trade union leader and nationalist. In 1913, with James Larkin, he organized a great transport strike in Dublin. He then formed the Irish Citizen Army, which joined with the Irish Volunteers in the Easter Week Rebellion of 1916. Connolly was one of the seven signatories of the Proclamation of the Irish Republic. He was later arrested and executed. Connolly was born in Edinburgh, Scotland, of Irish parents. He began work at an early age. He organized trade union movements in Belfast and Dublin.

Connolly, Patrick (1927-), became the Republic of Ireland's attorney general in 1982. He resigned the same year because of his association with a murder suspect. Patrick J. Connolly was born in Dublin. He graduated from University College, Dublin, and attended King's Inns. He was called to the Irish Bar in 1949 and to the Inner Bar in 1971. Connolly helped to defend Charles Haughey, who later became *taoiseach* (prime minister) of Ireland, in the 1970 arms trial and took a prominent role in the legal inquiry into a disastrous oil-tanker explosion at Bantry Bay, County Cork, in 1979.

Connors, Jimmy (1952-), an American tennis champion, was one of the best singles players in the world. In 1974, Connors won the men's singles title at three major tennis tournaments—the All-England (Wimbledon) Championships, the United States Championships, and the Australian Open. Connors also won the U.S. Open in 1976, 1978, 1982, and 1983. In addition, he won the Wimbledon men's singles title in 1982.

Connors, a left-hander, was known for an aggressive, hard-hitting style of play that put constant pressure on his opponents. He was particularly noted for his return-of-service and for his two-handed backhand shot.

James Scott Connors was born in East St. Louis, Illinois, and grew up in Belleville, Illinois. He attended the

University of California at Los Angeles (UCLA). In 1971, he won the National Collegiate Athletic Association singles championship. Connors became a professional tennis player in 1972.

Conquistadors were Spaniards who conquered Indian peoples in parts of Latin America mainly during the first half of the 1500s. *Conquistador* is a Spanish word meaning *conqueror*. Most conquistadors had little interest in exploration. Nevertheless, they were often the first Europeans to enter the regions they conquered, and some settled in those areas. The most famous conquistadors were Hernando Cortés, who defeated the Aztec Indians in Mexico; and Francisco Pizarro, who conquered the Inca empire in Peru. See also **Cortés**, **Hernando**; **Pizarro**, **Francisco**.

Conrad, Joseph (1857-1924), was a Polish-born author who wrote in English. He became famous for the novels and short stories that he wrote about the sea.

Conrad was born Józef Teodor Konrad Nalecz Korzeniowski near Kiev, in what was then Russian Poland. He left Poland at the age of 16 and arrived in England at the age of 20, unable to speak English. During the next 16 years, he worked his way up from deckhand to captain in the British Merchant Navy. He mastered his adopted language so well that he was able to write some of the greatest novels in English literature.

Conrad used the experiences of his life in many of his works. His voyages in the Indian Ocean and Malay Archipelago provided the material for some of his best-known novels. He began with *Almayer's Folly* (1895) and *An Outcast of the Islands* (1896), both set in Borneo.

Such later masterpieces as *The Nigger of the 'Narcissus'* (1897), *Lord Jim* (1900), *Typhoon* (1903), *Victory* (1915), and *The Shadow Line* (1917) are also set in the eastern seas. Several of his short stories, including "The Secret Sharer" and "Youth," are set there, too. "Heart of Darkness" (1902) is based on his voyage up the Congo River, and his novel *Nostramo* (1904) uses memories of his early voyages in the Caribbean.

The people of Conrad's day infuriated him by thinking of him as merely a writer of sea stories. But Conrad knew his works really dealt with universal problems. He used the concentrated little world of a ship to treat the general problem that obsessed him: How can society endure against all the destructive forces of the individual ego and the modern world? *Nostramo*, for example, presents an epic picture of the clash between capitalism and revolution in South America. Conrad also wrote two absorbing novels about revolutionaries in Europe, *The Secret Agent* (1907) and *Under Western Eyes* (1911).

Conrad was not particularly interested in character for its own sake. He was most interested in men who were actively pursuing their aims in life. Some, like the captain of the "Narcissus," triumph over weakness and evil. More often, the heroes in Conrad's fiction yield to the powers of weakness and evil in themselves and others. But Con-



Joseph Conrad

rad was not exactly a pessimist. He affirmed the value of the old-fashioned virtues—courage, fidelity, and discipline. Conrad was modern in realizing how enormously difficult it is for people to practise such virtues.

Conscientious objector is a person who, for religious or other reasons, refuses to serve in the military in defence of his or her country. Although all conscientious objectors regard the taking of human life as unacceptable, many are willing to do military service in non-combatant roles, often as stretcher bearers or medical corpsmen. A few conscientious objectors in such roles have received their country's highest awards for gallantry. Other conscientious objectors refuse to take any part in their nation's war efforts, accepting a punishment of imprisonment, or even death, rather than compromise their beliefs.

In the past, many societies equated conscientious objection with treason. The Nazis executed German pacifists. Until recently, Soviet citizens refusing military service could expect a lengthy term of penal servitude.

Traditionally, democracies have been more liberal in their attitudes towards conscientious objection. Religious exemption within the United States dates from 1661, when Massachusetts excused its Quaker community service in the militia. Both sides exercised considerable restraint in the American Civil War (1861-1865). The government incorporated extensive religious safeguards into compulsory service legislation passed in 1917, during World War I. Legislation passed in 1940 required an objector to demonstrate "religious training and belief," but not necessarily membership of a pacifist religious group. Religious belief was defined in 1948 as belief in a "supreme being." That phrase was later interpreted to include any vaguely religious philosophy. By the time the *draft* (compulsory service) was abolished in 1973, U.S. law relating to conscientious objection was very confused.

The United Kingdom had no traditions of conscription before World War I (1914-1918). During that war it treated conscientious objectors harshly, subjecting them to punishment under military law. However, during World War II (1939-1945), the UK adopted a far more conciliatory attitude, allowing conscientious objectors to seek alternative employment within the war economy.

Israel pursues a unique policy towards conscientious objection. All are expected to serve the defence effort except for members of certain religious groups. These members are automatically exempt from military service on the basis that army life would interfere with their religious practices.

Conscription, also called *military draft* or *national service*, is a method of selecting men, and very occasionally women, for compulsory military service. Traditionally, soldiers are conscripted soon after leaving school and serve for between one and three years. Conscription has been used by many countries during wartime, but by few countries during periods of peace. It has been abandoned by countries as divergent as the United States and Britain, Australia and New Zealand, India and Pakistan. Many others, particularly in Europe, have reduced their terms of service.

Conscription has been known in Europe for more than 2,000 years. Ancient Greece and Rome occasionally bolstered standing armies with conscripted men in time

of war. In medieval times, many cities in England and France introduced trained bands to protect themselves. The first compulsory military training on a large scale started in Switzerland in the 1500's. King Gustavus Adolphus of Sweden conscripted men in the 1600's, and France started conscription in the 1700's.

In the French Revolution and the Napoleonic Wars (1789-1815) large armies were conscripted but were stood down with the return to peace.

In the 1850's, Prussia introduced a scheme of limited conscription under which a small number of picked recruits were enlisted for a year to learn the rudiments of military procedure and thereafter transferred to the reserve forces. This system was reintroduced by the Nazis during the early stages of German rearmament in the mid-1930's.

Germany, France, Russia, and Austro-Hungary extended conscription with the outbreak of World War I (1914-1918). The United Kingdom broke a strong tradition of voluntary military service, when it started conscription in 1916. The threat of conscription spurred many Irishmen to enter into armed rebellion against British rule. Since becoming an independent country, the Republic of Ireland has never considered introducing conscription.

In World War II (1939-1945) all the warring countries used mass conscription. In 1957, the UK was the first European power to decide to abandon national service. Most of the other members of NATO soon reduced the numbers and length of service of conscription.

In Russia in 1991, conscription, once important to the Communist system, became increasingly unpopular. Many potential conscripts actively refused to report for duty and the system began to break down. In 1992, conscripted men from republics outside Russia began returning to their homes without permission.

India and Pakistan both have strong military traditions, but rely upon volunteer armies. But less stable countries, particularly those in Southeast Asia, still rely upon large conscript forces. In the early 1990's, Vietnam had more than one million in the army, mostly conscripts. Similarly North Korea had mainly conscript forces numbering about 780,000, and South Korea had 620,000.

New Zealand practised conscription between 1901 and 1930. Australia relied on volunteers in World War I. Both countries introduced conscription in World War II, although Australia sent only volunteers to serve in Europe and North Africa. New Zealand had conscription for much of the 1950's and 1960's, and abolished it with effect from 1973. Australia had compulsory military training between 1951 and 1957 and a ballot system between 1957 and 1959 and 1964 and 1972.

In the United States, conscription dates from the American Revolution (1775-1783). Militia men were drafted by individual states to fight against the British. Both sides in the American Civil War (1861-1865) used conscription. The United States used conscription during the major wars of the 1900's. A selective system of drafting people into military service became particularly unpopular in the 1960's and 1970's during the long Vietnam War. Conscription was abolished in 1973. In 1981, a list of possible draftees was started, in case the government decided to restart conscription during wartime.



Wildlife conservation requires setting aside areas where animal habitats are not disturbed. Mallards and other birds nest in a wildlife refuge.

Conservation

Conservation is the management, protection, and wise use of natural resources. Natural resources include all the things that help support life, such as sunlight, water, soil, and minerals. Plants and animals are also natural resources.

The earth has limited supplies of many natural resources. However, our use of these resources keeps increasing as the population grows and our standard of living rises. Conservationists work to ensure that the environment can continue to provide for human needs. Without conservation, most of the earth's resources would be wasted, degraded, or destroyed.

Conservation includes a wide variety of activities. Conservationists work to keep farmlands productive. They manage forests to supply timber, to shelter wildlife, and to provide people with recreational opportunities. They work to save wilderness areas and wildlife from human destruction. They try to find ways to develop and use mineral resources without damaging the environment. Conservationists also seek safe, dependable ways to help meet the world's energy needs. In addition, they work to improve city life by seeking solutions to such problems as air pollution, waste disposal, and urban decay.

Conservationists sometimes divide natural resources into four groups: (1) inexhaustible resources, (2) renewable resources, (3) nonrenewable resources, and (4) recyclable resources.

Inexhaustible resources, such as sunlight and air, cannot be used up. Water is considered inexhaustible be-

cause the earth will always have the same amount of water. But water supplies vary from one area to another, and some areas have shortages of clean, fresh water. The supplies of salt and some other minerals are so abundant that they are not likely to be used up.

Renewable resources can be used and replaced. They include plants and animals, which reproduce and so replace themselves. Most renewable resources cannot be stored for future use. For example, old trees must be cut down, or they will rot and become useless for timber. In addition, because most renewable resources are living things, they interact with one another. Thus, the use of one renewable resource affects others. For example, the cutting down of trees affects other plants and many animals, as well as soil and water resources. Soil may be considered a renewable resource because crops can be grown on the same land for many years if the soil is cared for properly. However, if the soil is allowed to be washed or blown away, it can only be replaced over hundreds of years.

Nonrenewable resources, such as coal, iron, and petroleum, cannot be replaced. These resources take thousands or millions of years to form. Their supplies are being depleted faster than new supplies can form. Most nonrenewable resources can be stored for future use. Minerals are sometimes left in the ground to save them for the years ahead. Little interaction occurs among most nonrenewable resources, and so the use of one nonrenewable resource has little effect on another. For example, the mining of coal does not affect the supplies of silver or copper.

Recyclable resources, such as aluminium and copper, can be used more than once. For example, aluminium

can be used to make containers and then be reprocessed and reused.

Some kinds of conservation have been practised for hundreds of years. In the late 1900's, conservation came to mean the protection of the environment through an understanding of *ecology* (see Ecology).

One of the most difficult challenges of conservation is to reconcile two, sometimes conflicting, goals—(1) to protect the environment and (2) to maintain or increase agricultural and industrial production. For example, the agricultural use of some chemical fertilizers and pesticides pollutes the environment but also greatly increases crop yields. Thus, most farmers do not want to stop using these chemicals. To solve such problems, new management approaches are required.

The difficult goals of conservation can only be achieved through the combined efforts of many people. Business leaders, government officials, scientists, and individual citizens must all work together to conserve natural resources.

The importance of conservation

Conservation is important to many people for a wide variety of reasons. Farmers may practise conservation to prevent erosion and to maintain the quality of the soil. City dwellers may be chiefly concerned about air pollution, inadequate parks, and decaying neighbourhoods. Nature lovers may support conservation because they appreciate the beauty and other values of wildlife and landscapes. Business executives may promote conservation to help ensure continuous supplies of minerals and other resources on which their industries depend. But in general, conservation is important for two basic reasons: (1) to meet demands for natural resources and (2) to maintain the quality of life.

To meet demands for resources. The demand for natural resources has steadily increased as a result of the growth of the world population and the rise in standards of living in many countries. While the demand for resources has increased, the supply has not, and some resources are being rapidly used up.

From 1650 to 1850, the world population doubled. Since 1850, it has more than quadrupled. Today, the world has about 5½ billion people. If the present rate of population growth continues, the number of people on earth will double every 41 years. Such a large increase in the population will result in even greater demands for natural resources. More land will be needed for living space and for growing food. More fuel and fresh water will be required. No one knows how many people the earth can support. But most conservationists believe the rate of population growth must be reduced to prevent depletion of many of our natural resources.

The rise in the standard of living in industrialized nations has created further demands for natural resources. In addition, many developing nations are working to raise their living standards and are increasing their demands for resources.

The high living standards in many nations are supported largely by the growth of industry. Industry uses huge amounts of fuel and other resources, and it depends on continuous supplies of these resources. However, unless conservation is practised, shortages of some resources may develop within the next 100 years.

In many cases, meeting demands for one resource makes it difficult to conserve another. The same land that is needed to produce food, wood, or fuel is often valued for its wildlife, recreational opportunities, or beautiful scenery. For example, the construction of a dam may provide water to irrigate farmland or to produce electric power. But it may also destroy scenic lands and wildlife habitats.

To maintain the quality of life. Conservationists use the term *quality of life* to refer to the health of the environment. Such factors as clean air and water, uncluttered living areas, and unspoiled scenic lands contribute to the quality of life.

Industrial development has created a high standard of living for a large number of people. But it has also damaged the environment in ways that impair the quality of life. For example, many factories emit smoke and other pollutants into the air and empty waste products into lakes and streams. As a result, the air in numerous cities is unhealthy to breathe, and the water in many lakes and streams is unsafe to drink or to swim in. Some methods of mining also cause pollution and may leave the land barren and scarred. In addition, the use of certain industrial products contributes to pollution. For example, car exhaust fumes are a major source of air pollution.

To maintain or improve the quality of life, natural resources must be developed and used in ways that cause the least possible damage to the environment. In addition, some places need to be preserved in their natural state and protected from industrial or agricultural development. Prairies, wetlands, forests, and other natural environments provide homes for many kinds of wildlife. They thus contribute to the *ecological diversity* of the earth. If such environments are not preserved, large areas will consist of *monocultures*, environments that support only a few species of plants and animals.

Monocultures have already replaced ecologically diverse environments in many parts of the world. For example, most of the prairies of North America have been replaced by fields of maize and wheat. As a result, such wildlife as pronghorns and prairie chickens, which once were plentiful on the prairies, are no longer abundant.

Kinds of conservation

This section divides the broad field of conservation into eight main categories. The eight kinds of conservation discussed here are (1) soil conservation, (2) water conservation, (3) forest conservation, (4) conservation of grazing lands, (5) wildlife conservation, (6) mineral conservation, (7) energy conservation, and (8) urban conservation.

Each kind of conservation has different problems and solutions. In many cases, however, the management of one resource affects several other resources. For example, the conservation of forests helps conserve water, soil, and wildlife resources. Forests absorb rain water and so keep it from running off the land too rapidly. They thus help prevent rain water from washing away the soil. Forests also provide homes for wildlife. In the same way, every living thing depends on and interacts with other living and nonliving things. Living things and their physical environment form an *ecosystem*.

Soil conservation. Soil is essential for the growth of plants, which in turn provide food for animals and



Soil conservation techniques include *contour ploughing* (ploughing across a slope) and *strip cropping* (alternating strips of close-growing plants and grain crops).

human beings. Soil consists chiefly of minerals mixed with *organic* (plant and animal) matter, air, and water. Soil forms from rocks and similar materials that are broken up into smaller particles by physical and chemical processes called *weathering*. The particles become mixed with *humus*, a substance formed from plant and animal remains. Bacteria in the soil break down the humus into nutrients needed by plants. See *Soil*.

The thin layer of fertile soil that covers much of the

earth's land was formed by natural processes over thousands of years. But in many areas, careless human practices have destroyed the soil in just a few years.

Rain water, wind, and other natural forces gradually wear away the soil. This process, called *erosion*, normally occurs very slowly. But people have greatly increased the rate of soil erosion by removing natural *vegetation* (plant life) to clear land for construction projects, mining operations, or farmland. Plants protect the soil from the direct force of raindrops and wind. Their roots hold the soil in place. Plants also absorb some rain water so that less runs off the land. Thus, fewer soil particles are washed away. Soil erosion is a major conservation problem in many parts of the world.

Farmers can reduce soil erosion by planting trees and leaving patches of natural vegetation between their fields and on other unploughed areas. The trees serve as windbreaks, and the plant cover slows the runoff of rain water. Many farmers also practise such soil conservation methods as *contour ploughing*, *strip cropping*, *terracing*, and *minimum tillage*.

Contour ploughing is practised on sloping land. Farmers plough across a slope, instead of up and down. The ploughed soil forms ridges across the slope. The ridges help slow the flow of rain water.

Strip cropping also helps slow the flow of rain water down a slope. Farmers plant grass, clover, or other close-growing plants in strips between bands of maize, wheat, or other grain crops. Grass and clover hold water and protect the soil better than grain crops do.

Terracing is a method of preventing soil erosion on hillsides. Farmers build wide, flat rows called *terraces* on the hillsides. A terraced hillside resembles a staircase with large steps. The terraces hold rain water and so prevent it from washing down the hillside and forming gullies.

Minimum tillage, also called *conservation tillage*, consists of several methods of reducing the number of times a field must be tilled. Normally, farmers till their



Terracing helps check soil erosion on hillsides. The terraces hold rain water and prevent it from washing down a hillside and forming gullies.



Water pollution can make lakes and streams unfit for most uses. This waterway is contaminated by wastes from a paper mill. A pollution control worker collects samples for testing.

fields three or more times a year. One form of minimum tillage is called *zero-tillage* or *no-till*. After harvesting a crop, farmers leave the *residues* (remains) from the crop on the field as a covering for the soil, instead of ploughing them under. During the next planting, the farmer prepares the seedbed with a device that leaves the residues between the crop rows. Zero-tillage not only provides cover for the soil but also conserves tractor fuel.

Another major conservation problem on farmlands is declining soil fertility, which is caused partly by planting the same crop in a field year after year. Maize, wheat, and other grain crops drain the soil of an essential chemical called *nitrogen* if they are grown on the same field for several years. Farmers can maintain the fertility of the soil by practising *crop rotation*, in which crops are alternated from year to year. The rotation crop is usually a *legume*, such as alfalfa or soybeans. Unlike maize and wheat, legumes restore nitrogen to the soil. See **Cropping system**.

Some farmers add plant remains or *manure* (animal wastes) to their fields to enrich the soil. Many use chemical fertilizers for this purpose. However, excessive use of some chemical fertilizers may decrease the ability of bacteria to decay humus and produce nutrients naturally. As a result, the soil may gradually harden and lose much of its ability to absorb rain water. The soil then erodes more easily. In addition, the chemicals from fertilizers may wash out of the soil and enter lakes, streams, and even wells, polluting the water. Excessive use of pesticides causes similar problems.

A common problem on irrigated farmland is the build-up of various chemical salts in the soil. Most irrigation water contains small amounts of these salts. In time, the salts accumulate in the soil and may reduce plant growth and ruin cropland. See **Irrigation**.

Water conservation. People require clean, fresh drinking water. People also use water for bathing, cooking, and cleaning. Farmers need water to irrigate dry croplands. Industries use water to produce electric power and in the manufacture of many products. Water is also important in recreation and transportation.

The demand for water is constantly increasing as a result of population growth and the expansion of agriculture and industry. The earth has an abundant supply of water, but the water is unevenly distributed. Some areas do not receive enough rainfall, while others receive more than they need. Many dry regions face serious water shortages. In some areas, people have drilled so many wells to provide water for irrigation that the level of the ground water has been greatly lowered.

Some rural areas and cities obtain water by damming rivers to create reservoirs. Dams are also built to control flooding. But in many cases, the construction of new dams to meet ever-increasing demands for water or to reduce flooding threatens wildlife.

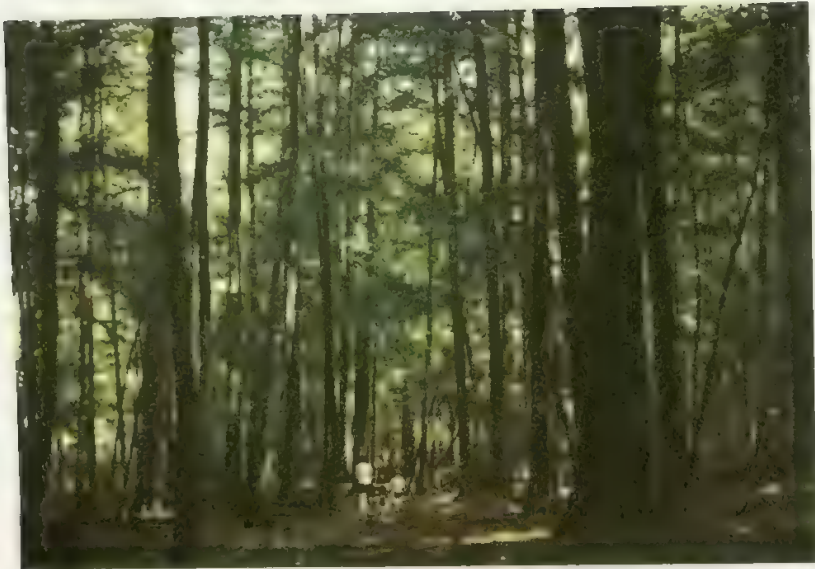
A dam may harm certain fish because it changes the flow of a river and causes less water to travel downstream. As the land behind a dam becomes flooded, some wildlife habitats are destroyed. Certain streams should not be dammed because they carry too much silt. On such streams, the reservoirs would quickly fill up with silt and become useless for storing water.

Water supplies for cities and farms can be increased partly through *watershed management* (the management of vegetation to prevent rapid runoff of rain water). Trees and other plants play an important part in the natural cycle of water. They keep water from running off the land and so allow it to filter into the ground. Underground supplies are thus refilled, and the water flows through underground channels into lakes and streams. When the plant cover is destroyed, this natural cycle is disturbed. Rain water runs off the land rapidly instead of filtering into the ground. Watershed management not only conserves water but also helps reduce flooding and soil erosion.

Some cities near seacoasts meet a small part of their water needs by desalting seawater. This process, called *desalination*, requires large amounts of fuel for energy and is therefore expensive. But solar energy may one day provide the cheap power needed for desalination.

Many communities have problems with water pollution. The disposal of sewage, industrial chemicals, and other wastes into lakes and streams makes the water unhealthy for wildlife and human beings. Cities and industries can reduce pollution by removing harmful substances from wastes before emptying them into lakes and streams. But waste treatment is expensive, and the job of cleaning up lakes and streams takes many years. See **Water; Water pollution**.

Forest conservation. Forests serve as sources of timber and as homes for wildlife. They also provide recreational areas for campers, hikers, and hunters. In addition, forests are important as watersheds. They absorb large amounts of rain water and so prevent the rapid



Forest conservation is important partly to provide recreational areas for hikers and other outdoor enthusiasts. Forests are also sources of timber and provide homes for many kinds of wild animals.

runoff of water that causes erosion and flooding.

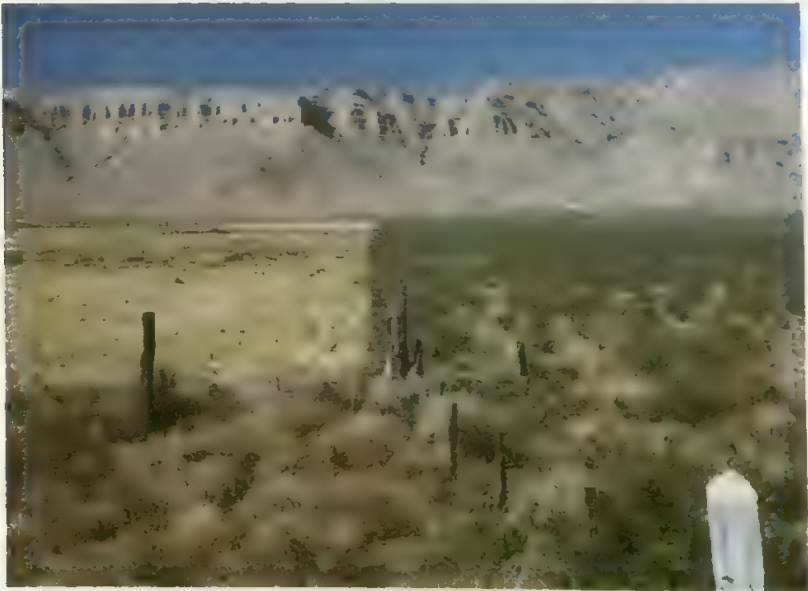
The conservation of forests that are used to produce timber depends on replacing trees that are cut down so that the forest has a *sustained yield*. Sustained yield is an approximate balance between the annual harvest and the annual growth of wood.

In some places, such as North America, forest destruction has been slowed. But in many other regions, especially those in tropical areas, forest destruction continues at a rapid pace.

Conservation of grazing lands. Grazing lands are grass-covered areas that are too dry to support farms or forests. These lands support a wide variety of wildlife, and provide pasture for cattle and other livestock. The chief conservation problem in these areas is overgrazing,

which results when too many animals graze an area or when animals stay in one place too long. The grasses die and are replaced by weeds and poisonous plants. Overgrazing results in increased runoff of water, which causes soil erosion. It also ruins wildlife habitats. In addition, the weeds and other plants that replace the grasses do not provide good pasture for livestock.

Grazing lands must be carefully managed to ensure a continuous supply of *forage* (plant food). To prevent overgrazing, conservationists must limit the number of livestock in an area, so that the *carrying capacity* of the land is not exceeded. The carrying capacity is the largest number of animals that an area can support without destruction of plant life. The livestock must be moved from time to time so that the grasses can regrow.



Grazing lands provide pasture for livestock. But improper management may result in overgrazing, which destroys the vegetation on the land. In this picture, the land on the left has been overgrazed, and the land on the right has been properly grazed.



Prescribed burning is one way to improve the vegetation on overgrazed land. The fire destroys weeds and other undesirable plants, and grasses can then regrow.

To improve the vegetation on overgrazed lands, managers sometimes practise *prescribed burning*, which involves burning off weeds and poisonous plants. They sometimes use herbicides, but many conservationists oppose their use because the chemicals harm wildlife. Another problem is the control of wild animals which sometimes prey on livestock. Many farmers want these predators killed or removed. But most conservationists want to protect them.

Wildlife conservation. Wild animals and plants make up an essential part of nature and contribute to the beauty and wonder of life. Wildlife also is important in scientific research.

Through the ages, human activities have contributed to the extinction of many wild animals, such as the moa in New Zealand, and the passenger pigeon in North America. Today, human activities threaten the survival of many other animals, such as the African elephant, the Australian numbat, the Southeast Asian orangutan, and the North American whooping crane.

In the past, hunting threatened the extinction of many kinds of wildlife. Today, many countries have laws that regulate hunting and fishing, though poaching continues in many places. However, the destruction of habitats is the main threat to wildlife today. The development of land for homes, farms, industries, and transportation leaves fewer areas where wild animals can nest, breed, and feed, and where wild plants can grow. Pollution also damages wildlife habitats. Chemicals from sewage, industrial wastes, and fertilizers and pesticides build up in lakes and streams and in the soil. Some pollutants collect in the tissues of plants and animals. Animals that eat these poisoned plants and animals are also affected.

A chief goal of conservationists is to ensure the survival of wildlife. Wildlife conservation includes the enforcement of hunting and fishing laws. But in many cases, an entire habitat requires protection and management. Some areas must then be set aside as national parks, nature reserves, or wildlife refuges.

Farmers can help conserve wildlife by leaving strips of natural vegetation along the edges of fields. They can also reduce the use of harmful pesticides and fertilizers.

The populations of some species of animals have been reduced to the point that the animals may not survive in their natural environments. In some cases, such animals can be raised in captivity and then released into a protected area. See *Extinct animal*; *Wildlife conservation*.



Strips of natural vegetation around ploughed fields can provide homes for such wildlife as deer and quail. Farmers can conserve wildlife by leaving such areas undisturbed.

Mineral conservation. Minerals include such substances as copper, gold, iron, lead, and salt. Industries use minerals to manufacture countless products.

The use of many minerals has increased greatly throughout the world. The use of aluminium, for example, has tripled since 1960. The use of nickel has more than doubled during this time. Some minerals, such as *bauxite* (the mineral from which aluminium is obtained) and salt, are plentiful. But the proved reserves of such minerals as copper, lead, nickel, and zinc may be depleted within 100 years.

Most minerals can be profitably mined only where they occur in large deposits. Industries first develop the highest-grade and most easily minable ores. When these are depleted, lower-grade and harder-to-mine ores are then developed. Many of these deposits can only be mined with advanced technology and large amounts of energy. Some deposits require so much energy to mine and refine that they cannot be profitably developed.

Deposits of minerals are unevenly distributed throughout the world. This uneven distribution of minerals has played an important role in history. For example, the ancient Romans fought against the Celts for the tin mines of southern England. A desire for gold was largely responsible for the Spanish conquests of lands in many parts of the New World.

The need for minerals continues to influence international relations today. Many countries must import large amounts of various minerals.

The mining and refining of minerals often results in destruction of scenic lands and wildlife habitats and in air and water pollution. One method of copper mining, for example, leaves large open pits on the surface of the land. Fumes from copper smelters, iron and steel mills, and other refineries pollute the air. Some refineries discharge wastes into lakes and streams.

Minerals can be conserved in a number of ways. Industries can reduce waste by using more efficient mining and processing methods. In some cases, industries



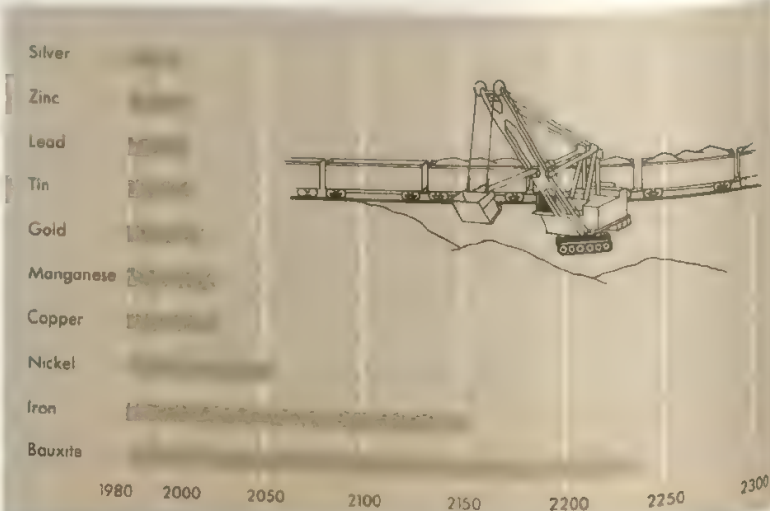
Recycling is an important method of conserving minerals. Aluminium cans are reprocessed, *above*, and turned into new products. Paper, glass, and other products can also be recycled.

can substitute plentiful materials for scarce ones. Some mineral products can be *recycled*. Although bauxite is plentiful, it can be expensive to refine. Recycling aluminium products does not require the large amounts of electricity needed to refine bauxite. Products made from many other minerals, such as nickel, chromium, lead, copper, and zinc, can also be recycled.

Energy conservation. All industries require energy to operate. Energy is also used in transportation and recreation. In addition, we use energy to warm and cool our homes, to cook food, to provide lighting, and to operate many appliances.

Lifetimes of some important minerals*

This graph shows how long the known reserves of certain minerals will last if they continue to be mined at the present rates. New discoveries and changes in prices and technology will probably increase these lifetimes.



*At 1987 production rates.
Source: U.S. Bureau of Mines

About 95 per cent of the energy used throughout the world comes from oil, coal, and natural gas. These substances are called *fossil fuels* because they developed from fossilized remains of prehistoric plants and animals. Large deposits of fossil fuels take millions of years to form. The earth has a limited supply of fossil fuels. But the worldwide use of fossil fuels has nearly doubled every 20 years since 1900. We will eventually use up the supply. As the supply dwindles, the cost of fossil fuels keeps rising.

Many nations are working to develop other sources of energy to reduce their dependence on fossil fuels. But every source of energy has some disadvantages that make its development difficult. The **Energy supply** article describes such sources of energy as nuclear energy, solar energy, and geothermal energy.

Until other sources of energy are further developed, nations must conserve fossil fuels to make the supply last as long as possible. Most of the responsibility for conservation rests with industrialized nations because they consume the majority of the world's energy.

Industries and individuals can conserve energy in many ways. Improved mining and manufacturing techniques can make the industrial use of fuel more efficient. Individuals can save fuel in their homes by installing insulation, which reduces the amount of fuel used for heating and air conditioning. People can also conserve energy by using less hot water and turning off unnecessary lights. Motorists can save petrol by driving smaller cars or using public transport.

The development and use of energy causes many environmental problems. For example, strip mining of coal destroys plant life and exposes the land to erosion. Blowouts of offshore oil wells and leaks from tankers produce oil spills that pollute the oceans. The burning of fossil fuels pollutes the air and results in the formation of *acid rain*, which can kill fish in lakes and streams. Sound conservation practices, such as restoring strip-mined land as closely as possible to its original condition, can help reduce environmental damage.

Lifetimes of fossil fuels†

This graph shows how long the proven reserves of fossil fuels will last if the present rate of production continues. New technologies, discoveries of new deposits, and changes in market conditions will probably lengthen these lifetimes.



†Based on data from the U.S. Energy Information Administration, 1990. These estimates are based on current production rates and do not take into account new discoveries or changes in technology. Source: BP Statistical Review of World Energy, 1991.

Urban conservation. In many countries, between 75 and 95 per cent of the population lives in or near cities. Since the 1800s, many cities have grown so rapidly that public services have not kept up with population increases. Cities thus have such problems as overcrowding, traffic jams, and inadequate public transportation systems. Most large cities are also noisy and suffer from air pollution, partly because of the large number of motor vehicles in use. In addition, many cities lack sufficient **parks and recreational facilities**.

Because of the drawbacks of city life, many people and businesses have moved to the suburbs. As suburbs nearest the city become crowded, people move farther and farther out, creating a condition known as *urban sprawl*. Much farmland has been lost to urban sprawl.



Solar collectors can be used to help heat houses and many other buildings. The development of new energy sources reduces our dependence on the dwindling supplies of fossil fuels.



The insulation of homes helps conserve energy by reducing the amount of fuel used for heating. *Loose-fill insulation* can be blown in between walls or into unfinished attic floors, *above*.

The goal of urban conservation is to improve the quality of life in cities and to make them more attractive and pleasant places to live. Many cities have *urban renewal projects*, in which rundown buildings are torn down and replaced by public housing or other new developments. In some cities, old houses and apartment buildings are being restored instead of replaced. Some cities are trying to reduce traffic problems and air pollution by improving public transport systems and encouraging their use. Most cities also need to develop more parks and recreational facilities. See *City*.

Early history of conservation

Prehistoric times. During early prehistoric times, there were not enough people on earth to use a large

amount of natural resources or to significantly damage the environment. Early prehistoric people thus had little need to practise conservation.

About $1\frac{1}{2}$ million years ago, people learned how to make fire. They built fires to cook food and to keep warm. They also used fires to kill animals. The fires drove the animals over cliffs or into traps. The fires also destroyed forests. Some scientists believe Africa's *savannas* (plains) resulted from burning of forests.

Near the end of the Pleistocene Ice Age, about 10,000 years ago, mammoths and certain other large land animals of the northern hemisphere died out. Some scientists believe that hunters killed off these animals. But others think climatic changes that occurred during the Pleistocene Ice Age caused their extinction.

The rise of civilization. A number of civilizations arose in the region surrounding the Mediterranean Sea during ancient times, between about 3000 B.C. and the A.D. 400's. Many people of the region tended large flocks of sheep and goats, which overgrazed the land. In time, the shallow soil of the region was eroded. The grassy pastures turned to wastelands, and large areas became desertlike. Much of the land in the Mediterranean region remains in poor condition today.

Although ancient civilizations in the Mediterranean region damaged the land, they also developed some conservation practices to keep farmlands productive. For example, the Phoenicians, whose culture peaked in about 1000 B.C., developed techniques of terracing hill-sides to prevent soil erosion. The Greeks introduced the practice of crop rotation sometime before the 300's B.C. The Romans, whose empire reached its greatest size in the A.D. 100's, brought knowledge about irrigation practices to the lands they conquered. Many conservation techniques later spread to northern Europe and formed the basis for wise land management there.

The Industrial Revolution was a period during the 1700's and early 1800's when industrialization developed in western Europe and the Northeastern United States. During this period, power-driven machines were invented and factories were organized. Machine-made



Serious pollution problems accompanied the development and spread of the Industrial Revolution during the 1700's and early 1800's. The air in Sheffield, England, *left*, and many other cities became clouded with smoke and soot from coal-burning factories.



Vast areas were set aside as national parks during the late 1800's and early 1900's. Yosemite National Park, in California, U.S.A., above, was created largely through the efforts of the American naturalist John Muir, right, shown standing with President Theodore Roosevelt, an avid conservationist.

goods produced in factories replaced handmade goods produced at home. Manufacturing, mining, and construction industries expanded rapidly. The Industrial Revolution resulted in increased production of many kinds of goods. It changed most Western nations from rural, agricultural societies to urban, industrial societies. It also brought many environmental problems.

During the Industrial Revolution, coal was burned to provide power for factories and to heat homes. As a result, smoke and soot polluted the air over London and other industrial cities. Wastes from iron smelting and other industries were dumped into lakes and rivers. The crowded cities also discharged large amounts of raw sewage into the water. Power-driven machines and improved tools increased people's ability to change the environment. They dammed rivers, cleared thick forests, turned vast prairies into cropland, and drained marshes.

During and after the Industrial Revolution, wildlife populations decreased at a rapid rate. With improved guns and traps, commercial hunters killed many animals. As people travelled to new lands, they brought animals that harmed native wildlife, especially on islands. Rats escaped from ships and preyed on birds and their eggs. Goats and sheep overgrazed land, destroying the food supply of wild animals. Wildlife habitats were destroyed as people cleared forests and drained marshes. Habitat destruction dramatically reduced wildlife populations, and it continues to be the major threat to wildlife. Since 1600, about 200 species of animals have become extinct, and many more have dwindled in number.

Conservation around the world

Almost all industrial countries face such problems as air and water pollution, urban crowding, and shortages of fossil fuels. Other problems affected areas, such as North America, that were opened up and largely developed in the 1800's.

North America. When the European settlers came to North America, they found a vast land rich in natural resources. They regarded nature as a force they had to fight and conquer, and they cleared forests to create farms. However, because of poor agricultural methods soil erosion soon damaged their land. The settlers then cleared new farms, believing that the land was limitless.

Although many areas had hunting laws to conserve wildlife, the laws were not well enforced. After the exploration of the West, trappers came to hunt animals for furs, greatly reducing their numbers. The millions of bison (American buffalo) on the plains were another resource. But commercial hunters slaughtered millions of bison. By 1889, only about 550 bison could be found alive in the United States. The careless use of many natural resources aroused some people in the United States to the need for conservation. The world's first national park—Yellowstone National Park—was established in 1872. Besides national parks, the United States began to protect its forests and establish wildlife refuges.

Some conservation projects were begun in the 1930's, partly to provide jobs for the unemployed. For example, the Tennessee Valley Authority (TVA) was set up to conserve the Tennessee region, which suffered from serious soil erosion and from flooding. The TVA planted trees and built several dams to control flooding and provide cheap electricity to rural areas. The government also promoted soil conservation in such areas as the Dust Bowl. The Dust Bowl was part of the Great Plains that had been damaged by poor farming methods, and where winds were carrying away the topsoil.

Scientific discoveries have made an important impact on the conservationist movement since the 1970's. Rachel Carson, a marine biologist, wrote about the de-



Fuel shortages in the 1970's forced car drivers to wait in long lines at the few stations that had petrol. The shortages dramatized the need for energy conservation.

structive effects of DDT and other pesticides that poisoned the food supply of animals and could also contaminate human food supplies (see Carson, Rachel). Most uses of DDT were banned in 1972. Publicity about DDT and other pollutants led to increasing public concern about environmental health.

Canada has a large land area and a fairly small population. It has huge supplies of natural resources, including many minerals. Most of its many rivers and lakes are not seriously polluted. Thus, many kinds of wildlife are as abundant as they were before the country was settled by Europeans. However, Canada has plans to develop some of the mineral resources of its interior. Without careful planning and management, the growth of the mining industry may result in the destruction of wildlife habitats and a decrease in animal populations.

Latin America has vast tropical rainforests, where many unique species of plants and animals live. It also has valuable mineral deposits. Mexico, for example, has large deposits of petroleum and natural gas.

Most of Latin America was colonized by the Spanish, who were primarily interested in obtaining gold and other raw materials from the New World. The Spanish generally restricted their settlements to mining centres and areas that had a favourable climate. Thus, until recently, much of Latin America consisted of wilderness areas that were largely undisturbed, though the land around most cities was severely damaged. However, parts of Mexico and Central America were more extensively settled and suffered from widespread forest destruction, overgrazing, and soil erosion.

Many nations of Latin America have a rapidly growing population, and most of the people are poor. To raise living standards, a number of countries have begun programmes to expand industry and agriculture. The tropical rainforests have commercially valuable trees, and timber production has increased. Many countries have cut through forests to build roads to reach remote areas where mineral deposits lie. In addition, farmers have cleared forests to provide land for growing crops. The soil of the tropical rainforests, however, does not generally make good farmland. Most tropical soils are not fertile, and few Latin American farmers can afford the large amounts of fertilizers needed to enrich the soil. In addition, tropical soils tend to harden when they are exposed to direct sunlight. They then become useless for growing crops. As a result, the farmers remove more trees each year to provide new cropland.

The expansion of industry and agriculture in Latin America has thus resulted in destruction of forests and wildlife habitats. Many countries have established national parks to conserve forests and wildlife. But in many cases, the parks are not well protected.

Europe. Much of the land in southern Europe has been severely damaged by the destruction of forests and by overgrazing of livestock. The soil has been eroded from hillsides, and the vegetation on grasslands is sparse and of poor quality. Many countries of southern Europe have begun programmes to replant trees on hillsides and to improve vegetation on grasslands.

In northern Europe, forests still cover much of the land, and environmental damage is not as great as it is in southern Europe. Northern Europeans were among the first people to recognize the environmental value of

trees, and they developed the science of forestry. They also have practised wildlife conservation for many years. In some countries, much of the land is privately owned and the landowners take responsibility for protecting wildlife. Most of the countries have also established nature reserves.

The United Kingdom has established 10 national parks and more than 30 areas of outstanding natural beauty to protect these areas from any harmful development. Pollution is now a matter of great concern and laws have been introduced to control it. Various government authorities are concerned with conserving ancient sites and buildings, and local authorities and independent organizations, such as the Wildfowl Trust, do much to foster environmental conservation projects. The Forestry Commission is generally responsible for tree management. The Wildlife and Countryside Act of 1981 aims to preserve sites of special scientific interest. However, many pressure groups, such as Friends of the Earth, Greenpeace, and the Green Party, believe that much more needs to be done to counter threats to the environment.

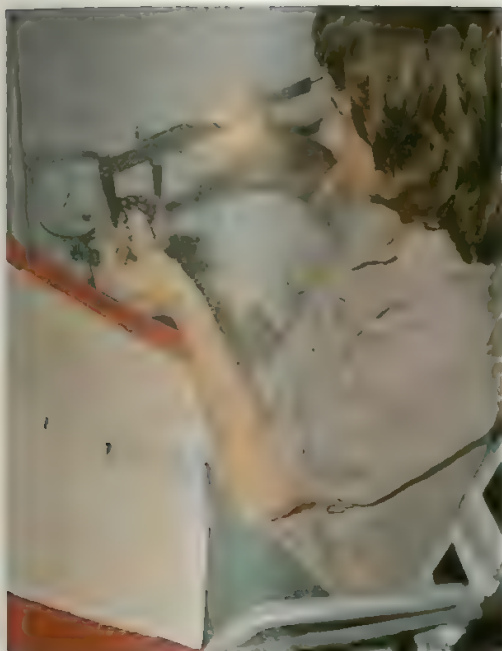
Russia, part of which is in Europe and part of which is in Asia, has the world's largest forest reserves. Russia makes considerable commercial use of its forests for logging and of its wildlife for food and manufactured goods. But the country has also worked to conserve its forests from too much logging and to protect polar bears and other wildlife resources.

Asia has about 3 billion people, more than any other continent. Many Asian countries have difficulty conserving their natural resources because the land must support so many people.

In Southeast Asia, many forests have been cut down to produce timber and to clear land for farms and industries. The destruction of forests has reduced the living space of wildlife. Much of Asia's wildlife is also threatened by overhunting. Many people kill animals for food or hunt them to sell to zoos, medical researchers, and



Forest destruction in Brazil and other South American countries continues at a rapid pace. These countries face the challenge of balancing economic development with conservation.



Measuring turtles contributes to the scientific study of these creatures, which live in the seas around Australia. Scientific information of this type is important to conservationists.

pet traders. Because of habitat destruction and overhunting, many large animals of Asia, including elephants, lions, rhinoceroses, and tigers, have become endangered. National parks and reserves have been set up as refuges for endangered species. They are also tourist attractions. They include the Gir Lion National Park, in Gujarat, India, the last natural habitat of the Asian lion; the Kaziranga National Park, Assam, a refuge for the Great Indian rhinoceros; and the Ujung-kulon Nature Reserve, Indonesia, refuge for the Javan rhinoceros.

In China, people have cut down most of the forests for wood, which has caused serious soil erosion. The soil is deposited in rivers and streams, which lowers the quality of the water. The Huang He, or Yellow River, is so named because the light-coloured soil gives the water a yellowish colour. The soil has also raised the riverbed. As a result, the Huang He often floods, causing great property damage and loss of lives.

In the Middle East, deserts cover much of the land. However, with irrigation, some areas have been turned into productive farmlands. Israel is well known for its irrigation efforts. However, some farmland in the region has been seriously damaged by the build-up of salts in the soil, a common problem on irrigated land.

Australasia. The conservation movement in Australia has several advantages over movements in other countries. Australia has a large area and a small population. It is also not yet highly industrialized. Its people have the opportunity to avoid mistakes made elsewhere.

Australia's wildlife includes many species of pouched animals called *marsupials*. Kangaroos and some other marsupials are grazing animals. They thus compete for food, water, and living space with the sheep that graze

on the ranges. Ranchers have killed many kangaroos because they believe the animals reduce the grass supply for sheep. Hunters have also killed many kangaroos for their hides and to sell their meat for use in pet food. Because the government feared kangaroos might become extinct, it banned the sale of live kangaroos and kangaroo hides and meat to other countries in 1971.

The introduction of European rabbits in Australia in the 1850s created a major conservation problem for more than a century. In Australia, these rabbits had no natural predators or diseases to limit their population and their numbers soared. After other control measures failed, Australian scientists succeeded in reducing the rabbit population in the 1950s by exposing the animals to a disease called *myxomatosis*.

Farmers and conservationists have clashed over such issues as pesticides being washed into the Great Barrier Reef. Conservationists are also concerned that Australia could one day have its own 'creeping Sahara' in low-rainfall lands unless destructive grazing practices are stopped. Conservationists also differ with the mining industry over such issues as the mining of uranium, because of the possible hazards of the nuclear power industry and nuclear weapons for which it is used.

Australia now aims to reserve a minimum of 5 per cent of the land for plant and animal life, including areas containing every kind of plant variety found in Australia. The Australian National Park and Wildlife Service, set up in 1975, helps to maintain the areas controlled by the federal government and to select key Australian landscapes and ecosystems to be conserved.

Until well into the 1960s, most problems of conservation in New Zealand arose in connection with the survival of various species of birds, such as the *takahe*, a flightless bird once thought to be extinct. New Zealand's first national park was set up in 1894. New Zealand's 10 national parks, which cover nearly 8 per cent of the country, come under a National Parks Authority, set up in 1952. New Zealand also has nearly a thousand areas reserved for their qualities of scenic interest.

Africa. In northern Africa, many people live by tending herds of sheep and goats. Along the southern edge of the Sahara, much of the land has been severely damaged by overgrazing. In these and areas, the sandy soil quickly erodes after the protective covering of vegetation has been removed. The land then becomes desert like. Overgrazing and droughts have contributed to the expansion of the Sahara, which advances along parts of its southern border by as much as 48 kilometres a year.

In central and southern Africa, wildlife populations have been reduced by the destruction of habitats and by overhunting. Many species of African wildlife have been overhunted because they are prized as trophies and as sources of valuable products. Elephant tusks are valued as sources of ivory. Leopards are prized for their hides, which are used to make expensive fur coats. Many African nations have passed strict hunting laws, but the laws are difficult to enforce in remote areas. The commercial value of elephant tusks, leopard hides, and other animal products on the world market makes *poaching* (illegal hunting) extremely profitable. To further protect its wildlife, many African nations have established large national parks and reserves. One of the oldest is the famous Kruger National Park in South Africa.

International problems. Many international conservation problems involve marine animals and other resources of the oceans. The commercial hunting of whales, for example, is an international problem. Because of overhunting, several species of whales are threatened with extinction. Some countries have tried to regulate the harvest of whales through participation in the International Whaling Commission, which sets limits on the number of whales that can be killed each year. But the commission does not have the power to enforce its regulations.

The conservation of animals, minerals, and other resources of the oceans may become even more important in future years. The demands of a growing world population and shortages of various resources may lead nations to further develop the resources of the world's oceans.

The United Nations, the International Union for the Conservation of Nature and Natural Resources (IUCN), and other organizations support worldwide conservation programmes. The IUCN gathers information on the world's endangered wildlife and publishes the data in its *Red Data Book*.

Related articles in *World Book* include:

Soil and water conservation

Coal (Strip mining)	Irrigation
Cropping system	Sewage
Dam (What does a dam do)	Soil
Drainage	Tennessee Valley Authority
Erosion	Water
Flood	Water pollution
Food supply	World Health Organization
Ground water	

Forest and wildlife conservation

Animal (How people protect animals)	Fishing Industry (Fishery conservation)
Arbor Day	Forestry
Bird (Bird study and protection)	Fur (Trapping)
	National parks



Farming in arid regions requires special techniques to conserve water. The almond tree being hoed by these farmers in Israel is surrounded by a bank of soil that helps retain rain water.

Salmon (Salmon conservation)
Trapping (Trapping and wildlife conservation)

Tree farming
Wildlife conservation

Mineral and energy conservation

Energy supply
Mineral

Petroleum (Petroleum conservation)

Urban conservation

Air pollution
City (City problems)
Housing

Park
Waste disposal

Other related articles

Balance of nature
Ecology
Environmental pollution

Greenpeace
Natural resources
Recycling

Outline

I. The importance of conservation

- A. To meet demands for resources
- B. To maintain the quality of life

II. Kinds of conservation

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| A. Soil conservation | E. Wildlife conservation |
| B. Water conservation | F. Mineral conservation |
| C. Forest conservation | G. Energy conservation |
| D. Conservation of grazing lands | H. Urban conservation |

III. Early history of conservation

- A. Prehistoric times
- B. The rise of civilization
- C. The Industrial Revolution

IV. Conservation around the world

- | | |
|------------------|---------------------------|
| A. North America | E. Australasia |
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| C. Europe | G. International problems |
| D. Asia | |

Questions

Why is conservation important?
Why did the settlers of North America have little concern for conservation?
How can individuals conserve energy in their homes?
How can farmers reduce soil erosion?
What is the goal of urban conservation?
What is the major threat to wildlife today?



The conservation of African wildlife is achieved partly through the establishment of reserves where wild animals are protected. These gnus roam a game reserve in Kenya.

Conservation of energy. See Energy (The conservation of energy).

Conservation of mass, Law of. See Mass.

Conservation of matter, Law of. See Matter (Conservation of matter).

Conservation of momentum. See Momentum.

Conservation of parity. See Parity (in physics).

Conservatism is an attitude or philosophy that places great emphasis on tradition. Conservatives want to *conserve* (save) traditional institutions, values, and ideas, and they rely on them as a guide to wisdom and goodness. Therefore, they seek progress in line with proven values of the past. But the word *conservatism* is confusing because its meaning varies with time, place, and circumstance.

Political conservatism. Political conservatives take a limited view of what politics can achieve. They believe that the aim of politics, or government, is to help promote a good life for people in society. However, most conservatives doubt that the good life can be brought about mainly by political means. They believe that all political problems are basically moral problems, and that legislation cannot significantly change human attitudes. Conservatives believe that the human potential for evil is as great as the potential for good. They doubt that evil will disappear with social reform or education.

Conservatives emphasize the performance of duties as the price of rights. They also believe in the desirability of maintaining social classes. Conservatives believe that all people have equal protection under the law, but they deny that all are born with equal advantages and influence in society. Conservatives maintain that only a few are natural leaders, and that the leadership provided by these few is essential to social order. For these reasons, conservatives consider political and economic leveling foolish and bound to fail.

Conservatives see a connection between freedom and private ownership of factories, and other means of economic production. They maintain that abolishing such private ownership would destroy individual liberty. Therefore, many conservatives believe that socialism and communism are the greatest threats to modern society.

History. The name *Conservative* was first used around 1830. It was applied to the descendants of the old British Tory Party, and the words *Tory* and *Conservative* are used interchangeably in Great Britain today. But conservative ideas were expressed as early as the 1700s in the writings and speeches of the British statesman Edmund Burke. Conservatism arose partly as a reaction to the excesses of the French Revolution and to the belief that human nature could become perfect through social change and political revolution. Conservatives argued that social change must be brought about not by revolution but, instead, within the framework of traditional ideas and institutions.

A true conservative should also be distinguished from a *reactionary*. Reactionaries want to revolutionize existing society according to a model in past history. True conservatives are never revolutionary. They want to preserve the best in the past and continue it into the future.

See also **Conservative Party**; **Judaism** (Conservative Judaism); **Liberalism**; **Right wing**.

Conservative Party is one of Britain's two main political parties. The second is the Labour Party. Conservatives in general seek to preserve institutions. They believe change should be *evolutionary*, not *revolutionary*; that is, Conservatives believe that they should improve upon the past by altering things gradually. Conservatives oppose *state intervention* (government involvement in such areas as the organization of industry). They favour private enterprise, individual freedom, national unity within Britain, and the maintenance of British influence overseas.

Policies. In foreign policy, the Conservatives tend to stress Britain's importance as a nation. But they do not seek to isolate Britain from other countries. Thus, in the 1970s, a Conservative government led Britain into the European Common Market. Great Conservatives, such as Benjamin Disraeli, a Prime Minister in the 1800s, have helped to boost Britain's standing in the world. Disraeli revived British enthusiasm for the Empire and made Queen Victoria Empress of India.

Between World Wars I and II, Conservative governments began the gradual process of changing the British Empire into a Commonwealth. After World War II they helped many Commonwealth countries to achieve independence.

In home affairs, Conservatives are prepared to create new institutions, but they avoid destroying institutions they regard as useful. Conservatives believe in spreading responsibility rather than centralizing it. In economic affairs, Conservatives favour free enterprise and oppose *nationalization*—state ownership and control. During the 1980s, a Conservative government sold many state-owned industries to private shareholders in a process called *privatization*. Conservatives favour low taxation on incomes and low government spending. Thus, easing the social welfare is one of their prime objectives. For example, Conservative governments in the 1960s passed the first factory acts to ensure decent and safe working conditions.

Organization. Throughout Britain, the Conservative Party has constituency associations run by volunteers. Paid party agents assist these volunteers. In London, the Conservative Central Office helps the work of constituency associations. The Conservative members of Parliament and peers form the Parliamentary Conservative Party. Constituency associations all belong to the National Union, which organizes the annual party conference. The Young Conservatives are the party's youth movement.

History. The Conservative Party developed in the 1800s out of the Tory Party, which first appeared in English politics in the late 1600s (see **Tory Party**). The word *Tory* is Irish and originally meant a robber. First used by party opponents as a term of abuse, it still survives as a term for Conservative. In 1833, the Tory leader Sir Robert Peel reshaped the party and gave it a new name—the Conservative Party.

In 1886, Liberal Unionists opposed to William Gladstone's Irish Home Rule proposals joined the Conservatives. They helped keep the Conservatives in power for most of the time until 1906. The Conservatives next held office as part of David Lloyd George's coalition government during World War I. They took power on their own again in 1922.

The great Conservative Prime Minister Sir Winston Churchill led a coalition government during World War II, but his party was defeated in 1945. Conservatives next held office from 1951 to 1964.

In 1965, the Conservative Party for the first time elected its leader by secret ballot. The successful candidate, Edward Heath, led the party to victory in 1970 and held office as Prime Minister until 1974. He was succeeded as leader in 1975 by Margaret Thatcher. Mrs. Thatcher became Britain's first woman Prime Minister following the election of 1979. She led the Conservative Party to victories in 1983 and 1987. In 1990, she failed to win outright a ballot for the leadership of the party and John Major succeeded her as party leader and as prime minister. In 1992, Major led the Conservative Party to a fourth consecutive term in power.

Related articles in *World Book* include:

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George	Thatcher, Margaret Hilda
Home, Lord	Tory Party
Labour Party	

Consonant is a letter or sound which in speech requires hindering of the breath by the tongue, teeth, or lips. There are two kinds of sounds. The open sounds with free breath are called *vowels*. The closed sounds, called *consonants*, are made with the breath wholly or partly checked. *Stopped consonants* require complete stoppage of the breath. They are *b, d, g, k, p, t*. *Open consonants* require only partial stoppage of breath. They are *l, m, n, r, w, y*. The *spirants* are open consonants that require friction in the oral passages. They are *f, j, s, v, z*. *H* is an *aspirant*, or *breathed*, consonant.

See also **Pronunciation; Vowel**.

Consort. See **Prince consort; Queen**.

Conspiracy is an agreement between two or more people to do something that is against the law. One person cannot conspire with himself or herself. It is usually not necessary that the planned act actually be committed or that any person be defrauded or injured. The act of conspiring constitutes a crime. Each person involved in the conspiracy is criminally responsible for everything that results, whether it was intended or not. Conspiracy is punishable by fines or imprisonment. In some countries if loss of human life results from a conspiracy murder may be charged.

See also **Coup d'état**.

Constable is a police officer. Constables may arrest people suspected of crime and serve writs. The word *constable* comes from the title of an official of the Eastern Roman Empire called the *comes stabuli*, or count of the stable. In France, the constable was once a member of the monarch's household, or a commander of the monarch's armies. In the United Kingdom and such countries as Australia and Canada, all junior police officers are called constables.

Constable, John (1776-1837), ranks with J. M. W. Turner as the leading English landscape painter of the 1800's. Constable is known mainly for his paintings of the rural areas near his birthplace, and in other parts of southern England. Constable sketched outdoors during the warmer months. During the winter, he worked in his studio and developed the sketches into paintings. Constable emphasized such environmental features as the appearance of the sky and clouds, and the effects of light and shadow on the landscape. He believed such features in a painting reflected nature accurately. Constable's fresh style influenced the impressionist painters of the late 1800's.

Constable's best-known paintings include *The White Horse* (1819), *The Hay Wain* (1821), *The Cornfield* (1826).

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John Constable's most famous works include *The Hay Wain*, which shows a wain, or farm wagon, crossing a river. The artist produced a full-size oil sketch of his subject, left, before starting the painting. He left the sketch unfinished with patches of brown canvas showing through.

and *Stoke-by-Nayland* (1836). Constable used vivid colours in many of his earlier paintings. After his wife died in 1828, he painted a number of dark, moody pictures that reflected his depression.

Constable was born in East Bergholt, near Ipswich, in Suffolk. In his youth, he began to draw the countryside near his home. A love of his native environment is apparent in all his work. Constable studied at the Royal Academy of Arts, in London, beginning in 1799. He was elected a full member of the academy in 1829. However, during his lifetime he received only limited recognition.

See also **Painting** (The 1800's (picture: *Stoke-by-Nayland*)).

Constance, Lake. See **Lake Constance**.

Constance, Peace of. See **Frederick I** (Holy Roman Emperor).

Constantine (pop. 448,578) is a trading centre in Algeria about 80 kilometres from the Mediterranean Sea. See **Algeria** (map). It lies on a cliff about 300 metres above the Rhumel River. Railways link Constantine, a major grain shipping point, with the nearby ports of Skikda and Annaba. Constantine was named after the Roman emperor Constantine the Great. He rebuilt it in A.D. 313 on the site of Cirta, a city that had been destroyed by war. After hundreds of years of Arab, Berber, and Turkish rule, Constantine was captured by France in 1837. France held it until 1962, when Algeria gained independence.

Constantine I (1868-1923) of Greece was king from 1913 to 1917 and 1920 to 1922. He succeeded his father, George I, who was assassinated. During World War I (1914-1918), Constantine pursued a policy of Greek neutrality. This activity brought him in conflict with the Greek prime minister, Eleutherios Venizelos, who favoured the Allies. In 1916, Venizelos began a revolutionary movement that was supported by the Allies. Constantine was forced to leave Greece, which entered the war on the Allies' side. His second son, Alexander I, became king. Alexander died in 1920, and the people voted to restore Constantine to the throne. In 1921, Greece went to war against the Ottoman Empire. Greece was defeated, and in 1922, the Greek military forced Constantine to give up the throne. His oldest son, George II, became king. Constantine was born in Athens. See also **Greece** (History).

Constantine II (1940-) of Greece was king from 1964 to 1973. He succeeded his father, Paul I. Constantine began his reign with much support from the Greek people. But conflict soon arose between him and prime minister George Papandreou over the extent of royal power, including control of the military. The king manipulated Papandreou into resigning in 1965. During the next two years, Greece experienced increasing social and political unrest. In 1967, the military seized power. Later that year, after trying to overthrow the military, Constantine fled Greece with his family. He went first to Rome and then settled in London. In 1973, Greece's military government declared him deposed. The next year, the Greek people voted to end the monarchy and make Greece a republic. Constantine was born in Psychico, near Athens. See also **Greece** (History).

Constantine, Learie (1902-1971), was one of the most talented cricketers the game has produced. He was a great all-rounder but was a particularly accom-

plished fielder. He played in the Lancashire League in England during the 1930's, and drew large crowds through his exciting play.

Learie Nicholas Constantine was born in Diego Martin, Trinidad. He studied law in England. On his return to Trinidad in the 1950's, he was elected a member in the country's first democratic parliament. From 1962 to 1964 he served as high commissioner to the United Kingdom for Trinidad and Tobago. He was knighted in 1962 and became a life peer in 1969. Constantine also served as a governor of the British Broadcasting Corporation and was a member of the Race Relations Board and the Sports Council.

Constantine the Great was the first emperor of Rome to become a Christian. He is also known as Constantine I. He was born about A.D. 275 and died in 337. During his reign, Christians regained freedom of worship, and the Christian church became legal. The Eastern Orthodox Churches regard Constantine as a saint. He rebuilt Byzantium (now Istanbul, Turkey), renamed it Constantinople, and made it his capital. He shifted the Roman Empire's strength from Rome to the eastern provinces, laying the foundations of the Byzantine Empire.

Constantine made many gifts to the Christian church including huge estates which he gave to the church in Rome. He built the first great Christian cathedral, the Lateran Basilica in Rome. He built other famous churches in and near Rome; and in Antioch, Syria (now Antioch, Turkey); Constantinople; and Jerusalem.

Constantine's official name was Flavius Valerius Aurelius Constantinus. He was born in Naissa (now Niš, Yugoslavia). His father, Constantius, became emperor of the western provinces in 305. Constantius died in 306, and his army proclaimed Constantine as successor. The system of shared rule between two senior and two junior emperors, started by Emperor Diocletian, broke down completely. Seven claimants struggled for power. In 312, Constantine attacked Maxentius, his major rival in the west. Constantine later told how a vision before the battle had promised him victory if he fought under the sign of the cross. In another story, he ordered the Greek letters *chi* and *rho*—the first two letters of Christ's name, to be marked on his soldiers' shields. With these letters on their shields, Constantine's forces defeated Maxentius at the Milvian Bridge, which crosses the Tiber River. As a result of his vision, Constantine became a strong supporter of Christianity.

In 313, Constantine arranged a partnership with Emperor Licinius, ruler of the eastern provinces. They met in Milan and issued a statement of policy that gave freedom of worship and equal rights to all religious groups. Constantine recognized the Christian church as a legal body with rights to hold property, and returned property that had been seized to Christians. For more than 10 years, Constantine and Licinius divided the empire. In 324, their rivalry resulted in warfare and a victory by Constantine, who then became sole ruler. Constantine made Constantinople his capital and the centre of Roman government.

In 325, Constantine presided over the first great *ecumenical* (general) council of the Christian church. The council met in Nicaea, in what is now northwest Turkey, to deal with disputes among Christians, especially with

the Arian heresy which considered Christ to have been of a different substance from God. More than 300 bishops from all parts of the empire attended. The council condemned Arianism and drew up a statement of essential beliefs, called the *Nicene Creed* (see *Nicene Councils*). Constantine was baptized a Christian on his deathbed. The empire was passed to his sons, Constantius, Constans, and Constantine II.

See also **Byzantine Empire** (History [Beginnings]); **World, History of the** (picture).

Constantinople. See **Istanbul**.

Constantinople, Battle of. See **Army** (table: Famous land battles).

Constellation is a group of stars visible within a particular region of the night sky. The word *constellation* also refers to the region in which a specific group of stars appears. Astronomers have divided the sky into 88 areas, or constellations.

The ancient Greeks, Romans, and people of various other early civilizations observed groups of stars in the northern two-thirds of the sky. They named these groups of stars after animals and mythological characters. For example, the constellation Leo was named after a lion, Pisces after two fish, and Taurus after a bull. The constellations Andromeda, Cassiopeia, Orion, and Perseus are named after characters in Greek mythology.

Between the early 1400s and the mid-1700s, European navigators explored the Southern Hemisphere and observed many constellations in the southernmost third of the sky. Mapmakers and explorers named these star groups after scientific instruments and other things as well as after animals. For example, the constellation Telescopium was named after the telescope. Musca was named after the fly, and Tucana after the toucan.

Some well-known groups of stars form only part of a

constellation. Such smaller groups are called *asterisms*. The Big and Little Dippers are examples of asterisms. The Big Dipper lies in the constellation Ursa Major (Great Bear), and the Little Dipper is part of the constellation Ursa Minor (Little Bear).

Some constellations can be seen only during certain seasons due to the earth's annual revolution around the sun. The part of the sky visible at night at a particular place gradually changes as the earth moves around the sun. Also, observers at different latitudes see different parts of the sky. An observer at the equator can view all the constellations during the course of a year, but an observer at the North or the South Pole can see only a single hemisphere of constellations.

Related articles in World Book include:

Andromeda	Cassiopeia
Astronomy (Why the stars seem to move; The sky at different latitudes; maps)	Hercules
	Orion
	Ursa Major and Ursa Minor

Constipation is a condition in which the bowel does not rid itself of waste materials as readily as usual. Constipated people do not have regular bowel movements and may have pain or tenderness over the colon. They may suffer from headaches and backache. Constipation can be caused by weakness of the bowel muscles or by strong, irregular contractions of these muscles. It may also occur when a person uses laxatives too frequently or does not eat enough of certain kinds of foods, especially those that contain fibre. In addition, constipation may accompany an illness that affects tissues or nerves of the bowel, such as the growth of a tumour that partially blocks the intestines.

When constipation results from a faulty diet, the patient should eat more green vegetables, fruit, whole grain bread and cereals, and other foods with fibre. The patient also should drink ample quantities of water. Constipation may be a symptom of a serious disease. If it persists, or is accompanied by rectal bleeding, it should be investigated by a doctor.

See also **Laxative**.

Constitution is a statement outlining the agreed basic principles of formal organizations ranging from national governments to private clubs. It establishes the structure and purposes of the organization and the rights of its citizens or members. It also defines the powers of officers, how they are selected, and how long they can stay in office. Constitutions may also be called *articles of association* or *charters* (see **Charter**).

In Western political philosophy, the principles of constitutional government often have been based on a belief in a *higher law*—a body of universal principles of right and justice that is superior to detailed, everyday law. In modern democracies, a constitution's function is to put everyone—including the rulers—under law.

Government constitutions may be *written* or *unwritten*. The British constitution is unwritten. It consists of tradition and custom concerning the powers of the monarch, Parliament, and the courts. Many parts of the British constitution were taken from written documents, such as the Magna Carta. However, the constitution itself has never been written out in a single document. The British constitution can be modified by Parliament.

The Constitution of Australia was proclaimed on Jan. 1, 1901, when the six separate colonies combined to



Constellations are groups of stars in a specific area of the sky. This map shows 7 constellations in the Northern Hemisphere.

form the Commonwealth of Australia. It defines the powers of federal Parliament—that is, the British monarch, who appoints a governor-general as the monarch's representative; the House of Representatives; and the Senate. It sets out the rules for electing members of the Senate and House of Representatives. The Constitution gives specific areas of responsibility, such as defence, to the federal Parliament. It forbids the states to do certain things, such as impose customs duties, or issue their own money. The Constitution contains provisions on finance and trade. It outlines the powers of the high court and its judges. The Constitution sets out rules that govern setting up new states and making alterations to the Constitution itself.

Most modern governments have constitutions based on a single document. In most democracies, the written constitution can be changed only by a special process, such as a special election. Such amending procedures reflect the belief that a constitution should deal with basic principles, and that special deliberation should be required to modify or replace these principles.

Many countries now have nondemocratic or military governments. In these governments, a constitution can be changed by *fiat* (a command or decree) of the ruling group. In such countries, a constitution is more a statement of purpose than a statement defining powers.

In actual operation, constitutions in most democratic countries are unwritten in the sense that the formal document is not the only vital element. Custom and how various governmental bodies interpret the constitution are equally important and sometimes dominant. Although the United States has a written constitution, under a power called *judicial review*, the Courts may declare acts of government *unconstitutional* if the acts are considered to conflict with the basic law of the constitution. Most countries have important *nonlegal* rules which do not come from the written constitution or court interpretation. If these nonlegal rules are an essential part of the system of government, they are part of the "constitution" in the broad sense of the term.

The Australian system depends on *conventions* (customary practices) as well as the Constitution. The Constitution states that the governor-general must choose ministers from Parliament. But only convention requires those choices to be supporters of the majority party in the House of Representatives. The law gives the governor-general the power to choose any members of Parliament, as well as the right to dismiss them.

See the *Government* section of each country article. See also the separate articles *Bill of Rights*; *Government*.

Constitution is a famous frigate of the United States Navy. Its popular name is *Old Ironsides*. The frigate was built at a Boston shipyard in Massachusetts between 1794 and 1797. It was 62 metres long. The hull was made of oak from Massachusetts, Maine, and Georgia, and the masts of white pine. It could carry provisions for a crew of 475.

The *Constitution* was launched on Oct. 21, 1797. It was unharmed in battles with the Barbary powers in 1803 and 1804. In the War of 1812, it won a battle near Cape Race against the *Guerrière*, an English warship. During this battle, the ship earned its nickname. A sailor is said to have seen shot from the British guns bouncing off the



The *Constitution*, better known as *Old Ironsides*, one of the most famous vessels in the United States Navy, is docked at the Charlestown Navy Yard in Boston, Massachusetts, U.S.A.

Constitution's sturdy sides, and exclaimed that the ship had sides of iron. Isaac Hull, an American naval officer commanded the frigate. Following a number of other battles, the *Constitution* was condemned in 1830 as unseaworthy and was ordered destroyed.

The poem "Old Ironsides," by Oliver Wendell Holmes, in which he wrote:

Oh, better that her shattered hulk
Should sink beneath the wave,

aroused public sentiment, and the vessel was rebuilt and restored to service in 1833. In 1855, it was put out of commission at Portsmouth Navy Yard, in New Hampshire, and used as a training ship, but was again rebuilt in 1877. In 1897, a hundred years after its launching, the *Constitution* was turned into a barrack ship in Boston.

Between 1927 and 1931, American children raised money to help repair and restore the vessel so it could be preserved as a memorial. In 1930 Congress appropriated \$300,000 to complete the work. On July 31, 1931, *Old Ironsides* was commissioned into active service. After sailing 35,400 kilometres, it returned to the Boston Naval Shipyard on May 7, 1934. The *Constitution*, still in commission, is docked at the Charlestown Navy Yard in Boston. It is the oldest warship afloat in any of the world's navies.

Constitutions of Clarendon were an early attempt, in England, to define the boundaries between the rights of the Church and the jurisdiction of the Crown. They were drawn up by Henry II and presented for acceptance by the Church at a council at Clarendon, near Salisbury, Wiltshire, in 1164. The sixteen "constitutions" asserted various rights of the king, and of his courts, to

jurisdiction in certain ecclesiastical matters. Clergy convicted of criminal offences were to be punished by civil courts. The Church opposed these ideas.

Constitutional monarchy. See **Monarchy**.

Construction, Building. See **Building construction**.

Construction engineer. See **Engineering**.

Construction equipment is machinery used to build and demolish bridges, buildings, and other structures. These machines usually save labour, money, and time. One of them can do more work in an hour than a hundred workers using hand tools could do in a day. The chief kinds of building machines include (1) earth-moving machinery, (2) hoisting and material-handling machinery, and (3) pumping machines.

Earth-moving machinery is used to excavate, haul, and level earth and rock. These machines clear the way for the construction of bridges, buildings, and roads.

Construction workers use machines called *tractors* to push or pull trailers, wagons, and other equipment. *Crawler tractors*, or *caterpillars*, move on revolving *crawler tracks*, which resemble the treads of a tank. These tractors are used on soft ground and steep slopes and can move heavy loads. *Rubber-tyred tractors* carry lighter loads and can travel farther and at higher speeds. See **Tractor**.

Tractors that have heavy steel blades mounted in front are called *bulldozers*. The slightly curved blades clear away boulders, ground, trees, and underbrush. Bulldozers also excavate and level earth. See **Bulldozer**.

Machines called *graders* have a long, horizontal blade underneath. The operator can move the blade to either side of the machine and adjust it to a tilted or vertical position. Graders are used to grade and shape the surface of the ground.

Construction crews use *scrapers* to excavate and haul earth in dry, fairly flat areas. A blade under the machine digs up soil, which is loaded directly into the wagonlike part of the scraper for hauling. Some types of scrapers are pulled by a tractor, but others are self-powered.

The chief kinds of shovels used in excavation work include *backhoes* (or *backacters*), *draglines*, and *power shovels*. Each of these machines stands on a movable platform and has a large scoop bucket with a tooth-shaped bottom edge.

The buckets on backhoes and power shovels are attached to a long pole called a *boom*, which can be raised, lowered, or rotated. The bucket on a dragline hangs from a cable attached to the boom. The buckets on backhoes and draglines are pulled toward the machine to load. Both backhoes and draglines can dig below the surface on which they stand.

Construction crews often use backhoes to dig trenches for pipelines and sewers. Draglines are used to dig canals, ditches, and other excavations. *Face* or *forward* shovels dig away from the excavator. They are often used in quarry and hillside cuts.

Tractors called *front-end loaders* have a scoop bucket in front to dig and load material into trucks or wagons. They are easy to manoeuvre and have replaced power shovels for many kinds of construction operations.

Hoisting and material-handling machinery is used to transfer construction materials from place to place. Construction crews working on tall structures use hoist-

ing machines called *cranes* and *derricks* to lift steel beams and other parts. These machines have a movable boom with a pulley at the top. A lifting hook, which holds the materials that are being raised, hangs from a cable that runs through the pulley. Cranes can be mounted on moving platforms and are used more often in construction work than derricks, which are stationary machines. See **Crane**.

Companies working on tall buildings use *material lifts* to raise crews, masonry, and various construction materials. The lifts consist of steel towers with hoist-operated platforms that travel up and down the side of a building.

Dumpers or *dump trucks* haul heavy loads of earth, gravel, and sand over unpaved roads and unload in front of the driver.

Other material-handling machines include *mobile cement mixers* and *conveyor belts*. Companies use *mobile cement mixers* to mix concrete while hauling it to work sites. Materials move on conveyor belts inside buildings or over rough ground (see **Conveyor belt**).

Pumping machines are used in construction work to move water and other substances from one place to another. Pumps move clean water to mix with cement and remove dirty water from excavation pits.

Construction workers often use *centrifugal pumps*, which have blades that rotate at high speeds. The blades create suction that pulls water into the pump through an intake pipe. The water rotates with the blades and is forced out through an exit pipe.

Water that contains large amounts of solid waste is called *slurry* and can be moved by *diaphragm pumps*. Such pumps have a flexible plate called a *diaphragm* that moves back and forth, forcing the slurry through the pipes.

Another kind of water pump is the *submersible pump*. This pump operates under water. It is driven by an electric motor that has a waterproof covering.

Wet concrete is moved by *concrete pumps* to areas of a construction site where it is needed. These pumps have a piston that moves back and forth. The motion of the piston opens valves that allow concrete to pass through pipes to the site.

Other construction machinery prepares land and materials for construction. Self-propelled or tractor-drawn *rollers* press down ground to make it more compact and stable before paving. The various types of rollers include smooth, steel drums; multityred wheels; and drum rollers.

Machines called *crushers* break large rocks into sand or gravel used to make paving material. *Asphalt mixers* and *cement mixers* combine sand and gravel with cement to make paving or building materials. See **Road**.

Devices called *piledrivers* drive *piles* (posts that support buildings and other structures) into the ground. Pile-driving machines use guiding tracks called *leaders* or *leads* set into the pile frame. The hammer is hoisted to the top of the leader and released to drop onto the pile. See **Building construction**.

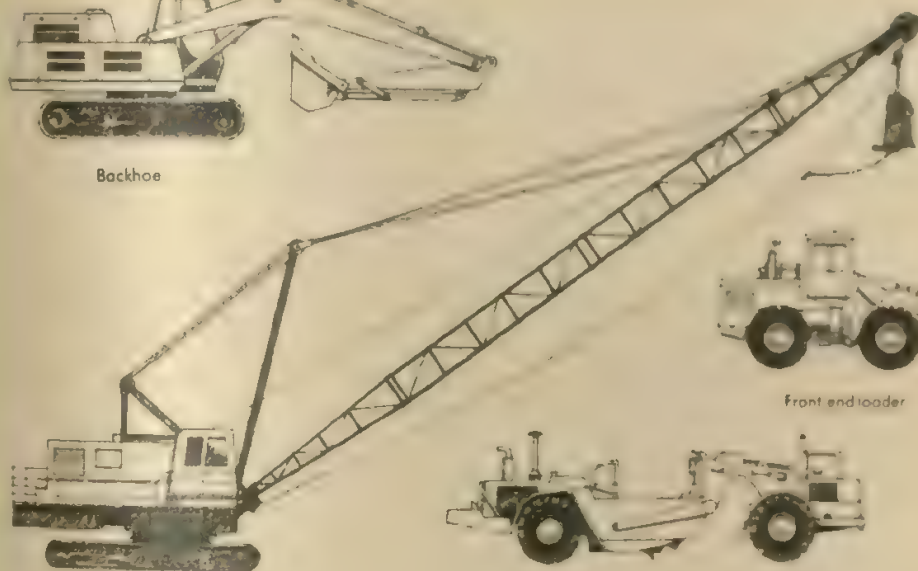
Demolition machinery is used to demolish structures and pavement. Construction crews often use a steel *demolition ball* to smash walls. The ball is suspended from a hoisting crane that swings it against a building. The hammer on a small pile-driving machine can be dropped to break up floors and pavement.

Some construction equipment

Heavy machinery is used in most types of construction work. Workers use some kind of construction equipment to excavate, haul, and level earth and rock. Other kinds are used to transfer materials from place to place, to drive piles, and to pump concrete from one location to another.



Backhoe



Dragline



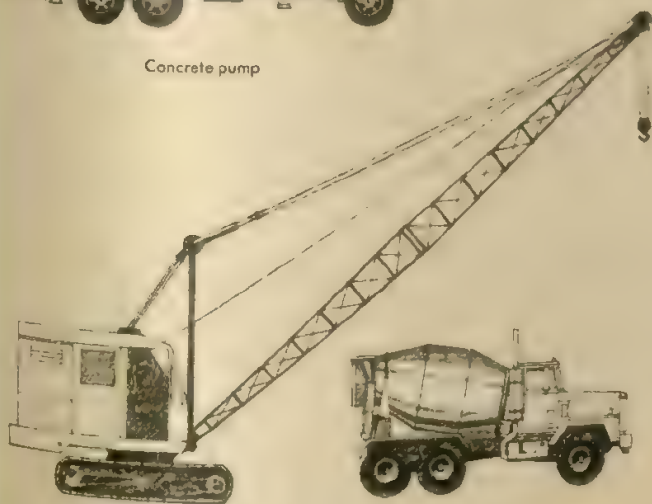
Front-end loader



Scraper



Concrete pump



Crane



Cement mixer



Pile-driving machine

Hard objects can be broken up with *pneumatic* and other types of *drills*. These drills also make holes that crews pack with explosives to destroy an entire building or bridge.

Consul is an official appointed by the government of one country to look after its commercial and cultural interests in a city of another country. A consul differs from a diplomatic representative in that he attends chiefly to business and cultural matters, while the diplomat is interested chiefly in political relations (see **Ambassador**). Consuls issue birth, death, and marriage certificates to citizens who are temporarily within their jurisdiction, regulate shipping, and aid citizens who are travelling abroad. For example, they help tourists who are arrested or robbed in a foreign country. They may also issue visas to foreigners travelling to their country.

The consular service of any leading country is divided into three ranks: consuls-general, consuls, and commercial agents. The consuls-general are in charge of all consuls in a district. The commercial agents, although they have the same duties and powers as consuls, are not officially recognized by the government. The powers and duties of consuls are often determined by treaty.

The title *consul* was given to the two highest magistrates of the Roman republic during ancient times. The insignia were the purple-bordered toga, a staff of ivory, and an ornamental chair. The title, without the function, was retained under the empire.

During the French Republic, from 1799 to 1804, the three chief magistrates were consuls. Napoleon Bonaparte, the first consul, held all the real power in the government.

See also **Foreign Service**.

Consumer cooperative. See **Cooperative**.

Consumer Price Index is a statistical measurement usually used to describe changes in the retail price of goods and services in a particular area, region, city, or country. In the United Kingdom, it is called the *Retail Price Index*. The Consumer Price Index compares the current cost of certain goods and services with their cost at an earlier time.

The index is based on the price of a selection of items bought by a typical household. Each item is given a share of the index, depending on its importance to the household. The total cost of these items at a specific point in time is then given a value, usually 100. This value provides the *base* of the index. Researchers record subsequent changes in prices, and the index rises or falls according to the changes. For example, an average household may have spent 200 British pounds a week on clothing, food, rent, and other items, such as televisions and refrigerators, during the base period of the year 1985. If all these costs doubled over the following ten years, the index in 1995 would be 200. The index would show that consumer prices had risen by 100 per cent over the ten-year period.

Items included in the index vary from country to country. In developed countries, the index will reflect the lifestyles of the people and may include such items as television sets, video recorders, washing machines, and holiday travel. In less developed countries, the index will be taken up almost entirely with the cost of clothing, food, and travel to work, which are the most important items purchased by the average household.

Governments usually measure changes in the Consumer Price Index every month, every four months, and every year. The index is the usual measure of a country's *inflation rate* and is an important indicator of economic performance. Many government and private organizations use the index as a yardstick for revising wages and other payments to keep pace with changing prices.

See also **Cost of living**; **Inflation**.

Consumer protection. See **Consumerism**.

Consumerism is a movement that promotes the interests of buyers of goods and services. It works to protect consumers from unsafe or low-quality products; fraudulent advertising, labelling, or packaging; and business practices that limit competition. Consumerism also known as *consumer protection* or the *consumer movement*, is active in many countries.

Consumerism includes activities by consumers themselves, as well as government action. The movement seeks to provide adequate information about products so that consumers can make wise decisions in purchasing goods and services. Consumerism also tries to inform consumers of effective means of obtaining compensation for damage or injury caused by defective products.

Consumer groups exist in many countries. In Britain, for example, the Consumer Association tests goods and investigates services, and then publishes the results. In Australia, there are consumer affairs agencies in the states and territories. In developing nations, consumerism is gaining strength, but it is still confined largely to urban areas. Such groups campaign for improvements in consumer-protection legislation and agencies.

The rise of the consumer movement has had major effects on business and industry. Many companies have become more responsive to the needs, wants, and safety of consumers. Other firms have not been responsive to these concerns. Some of them have experienced financial losses and unfavourable publicity resulting from legal action by dissatisfied consumers and government-ordered recalls of defective products.

The consumer's rights

Consumer groups and many other people believe consumers have several basic rights. For example, they believe consumers are entitled to (1) products whose quality is consistent with their prices and the claims of manufacturers; (2) protection against unsafe goods; (3) truthful, adequate information about goods or services; and (4) a choice among a variety of products. Buyers also have certain responsibilities. For example, they must use a product for the purpose intended by the manufacturer, and they should follow the instructions provided with the product.

The right to quality. Warranties and money-back guarantees provide assurances that a product will live up to the claims of the manufacturer. Most warranties are written statements that promise repair, replacement or a refund if a product fails to perform as the manufacturer said it would for a certain period of time. A money-back guarantee promises a refund of the purchase price if the buyer is not completely satisfied.

Legislation requires that warranties be written clearly so they can be easily understood by the consumer. They also give the consumer the right to an *implied warranty*.

an unwritten guarantee that the product is suitable for the purpose for which it has been sold. For example, a hairdrier should dry hair.

The right to safety. Legislation in many countries provides that food must be pure, wholesome, and fit for human consumption. Safety in another form is ensured by enabling a person injured by certain defective goods to sue the seller. *Standards authorities* exist to improve the safety and quality of many products, such as electrical goods and other household items. Such authorities do not always have legal powers effective against manufacturers. They simply test goods and recommend those of the best quality.

The right to information. Advertising is an important means by which manufacturers and sellers give information to consumers. Regulations prevent advertisers from making fraudulent or untruthful claims. Consumers also acquire information through labelling on goods. This labelling is also regulated by law. Packaged food must be labelled to show contents and weight, and the manufacturer's name and address must be given. Dates on food products show how fresh they are.

Certain types of selling are specially regulated by law. Door-to-door selling and the sale of goods on hire purchase or other instalment plans are regulated so that consumers have the right to wait a short time before making up their minds whether to buy or not. Legislation ensures that sales documents signed as part of credit agreements are clear, and contain all the conditions of sale, and that the sale is not legally binding immediately.

The right to choose. In many countries, the government regulates business to promote free and fair competition. Legislation prevents business from forming monopolies. Where a monopoly exists, consumers are forced to buy from one manufacturer, who then has unrestricted freedom to charge high prices.

History of the consumer movement

Early buyer-seller relationships. Some of the first attempts to protect consumers occurred during the Middle Ages. Guilds established by craftworkers set standards for products sold by their members. Another form of early consumer protection consisted of laws against *usury*, the lending of money at an excessive rate of interest. These laws regulated the rate of interest that moneylenders could charge borrowers.

Nevertheless, the market place was ruled by the principle of *caveat emptor*, a Latin phrase meaning *let the buyer beware*. People made most purchases from local shopkeepers or craftworkers and were responsible for detecting faulty merchandise. If dissatisfied with the quality or price, they complained directly to the person who made or sold the product.

Beginnings of consumerism. During the late 1800s and early 1900s, the sale of many impure and unsafe products led to increased consumer interest in legislation that established standards of quality.

During the 1950s and 1960s, consumer awareness increased, particularly in the United States, as a result of efforts by various crusaders.

During the 1970s, a period of inflation, consumers became increasingly effective in exercising their rights.

Inflation helped the growth of consumerism because of greater public concern about the cost and quality of products when prices go up continually.

Related articles in World Book include
Advertising Nader, Ralph
Clothing (Protecting the public) Sinclair, Upton
Monopoly and competition Textile (The textile industry)

Consumption, a disease. See Tuberculosis.

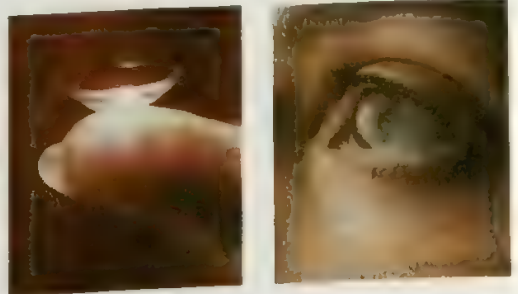
Consumption, in economics, is the amount of money that is spent on goods and services during a specified period, usually one year. The calculation of a country's consumption includes not only consumer goods such as clothing, food, and household appliances. It also includes raw materials such as building materials, cotton fuel oil, and metals.

A country's consumption is usually the equivalent of about 80 per cent of its total income. Public or government consumption traditionally includes spending on defence. Personal consumption is the money spent by families on the goods and services they need and want. The amount they spend is chiefly related to their *disposable*, or *after-tax income*. After-tax income is the amount of income that remains after income taxes and other taxes have been paid. Other influences also affect their consumption. These may include the cost of credit and the rate of inflation, which may affect their attitude to saving. Young people tend to spend nearly all their income while those in middle years may want to save for their old age.

Families with low incomes tend to spend a larger part of their earnings on essentials such as food and housing than do families with higher incomes. Those with the lowest incomes spend more than they earn and are forced into debt. As incomes rise, families tend to spend a larger part of their earnings on such items as clothing, education, and entertainment. John Maynard Keynes, a noted British economist, was one of the first to emphasize the close relationship between income and consumption (see Keynes, John Maynard).

Related articles in World Book include:
Consumerism Marketing
Economics (Consumers) Production
Income Standard of living

Contact lens is a device used to correct an eye's nearsightedness or farsightedness. Contact lenses can be made of hard or soft plastic. They float on a thin layer of tears on the surface of the *cornea* (clear front surface of



Contact lenses float on the eye's natural tear layer, *above right*. Balanced on the tip of a finger, *above left*, the lenses can be placed on the eye.

the eyeball). Contact lenses are curved to focus light rays on the retina. When the light rays are properly focused, a person sees clear images of normal size. Contact lenses provide more natural vision than glasses because they also allow normal side vision.

Most people wear contact lenses instead of glasses to look better and to feel more confident. Athletes and other active people like contact lenses because the lenses are less obstructive than glasses.

Hard contact lenses came into use in the early 1950's. They are made of rigid plastic and are relatively easy to clean and sterilize. Hard contact lenses that allow oxygen to pass through to the eye are called *gas permeable contact lenses*. These lenses are produced from special plastic. For many wearers, gas permeable contact lenses are more comfortable than normal hard contact lenses. Hard contact lenses are useful in correcting such eye disorders as *keratoconus* and *astigmatism*. These are conditions caused by a misshapen cornea.

Soft contact lenses originated in the early 1970's. They are softer and larger than hard contact lenses. Soft contact lenses absorb moisture and contain water. This composition enables the lenses to bend easily and makes them more comfortable than hard contact lenses. Originally it was necessary to remove soft contact lenses from the eye once a day. Now a type of soft contact lenses called *extended-wear contact lenses* can be worn on the eye without removal for up to seven days.

Soft contact lenses are more likely to cause infection than other types of contact lenses because impurities or bacteria may get into the water in the lenses. To avoid infection, wearers of soft contact lenses must regularly and thoroughly clean them in a special solution and sterilize them. A type of extended-wear contact lenses called *disposable contact lenses* can be worn for a week and then discarded and replaced with new ones. These lenses do not require cleaning or sterilizing.

Special types of contact lenses have been developed for unique needs. People with normal vision who want to change the colour of their eyes may buy contact lenses that come in different colours and that do not alter vision. Some soft contact lenses are used to treat diseases. They contain medicine that is gradually released to the eye.

Both hard and soft contact lenses have been developed for use as bifocal contact lenses. These lenses are designed to help people who have trouble seeing both at a distance and close up. They are made to replace bifocal glasses. Wearers look through one part of the lenses to see in the distance and through another part to see close up. The success rate of bifocal contact lenses remains limited for various reasons.

Monovision contact lenses offer another way to correct a problem with near and distant vision. A wearer uses a lens in one eye for close vision and one in the other eye for distant vision. Monovision lenses allow only one eye to be used at a time, and wearers sacrifice some depth perception.

Contagious disease. See Disease.

Containerization is a method of shipping freight by placing it inside large metal boxes called containers. Containerization helps prevent damage to the freight. Goods can be packed inside the container before leaving the factory where they were made and can remain safely inside until the container reaches its destination. Containerization also reduces the time and cost required to load freight onto a vehicle or unload it.

Effects of containerization. Containerization greatly affected both world trade and transportation. Road, rail, and sea transportation have all felt the effects. Chief among these effects was a dramatic increase in the amount of freight being transported. Containerization brought new more efficient working methods that saved time and allowed larger loads to be shifted.



Containerization has revolutionized the work of modern docks such as those at Tilbury in Essex, England. Cranes and other handling equipment make loading and unloading cargo much more efficient.

Dock labour practices changed with the coming of containerization. Machines, not men, did most of the work, loading and unloading the heavy containers. Large labour forces were no longer needed, and many dockworkers' jobs were no longer necessary. Ports with modern container-handling machinery cut costs and attracted more business than old-fashioned ports. Special ships for carrying containers were built, and by the 1990s container ships made up more than 6 per cent of the world fleet.

Modern container traffic operates worldwide. Many of the world's leading container ports are in the Asian and Pacific regions. They include Hong Kong and Singapore, the two busiest container ports in the world. In Europe, Rotterdam in the Netherlands is the leader in container traffic. In the United Kingdom newer ports such as Felixstowe have prospered from containerization, while older ports such as Liverpool and London have declined.

Containerization has changed port design. A container port has giant waterside cranes that lift the containers on and off the ships. Instead of warehouses there are large storage yards where thousands of containers are left while waiting to be loaded or moved inland by trucks or trains.

Containerization has also affected railways. Goods trains no longer drop off or pick up freight wagons at almost every station. Instead, freight trains operate between a limited number of sorting yards. Trucks bring freight containers to these yards to be loaded onto trains.

Containers and container ships. Most containers are made of aluminium, steel, fibreglass, or plywood, and can be easily transported by aeroplane, ship, railway, or truck. An *intermodal* container is one that can be used to transport freight by two or more kinds of vehicles—by train and ship, for example, or by truck and plane. Most containers are reusable. The size of a container depends on the vehicle used. The largest containers are carried by ships or trains. Most of these containers range from 6 to 12 metres long and are about 2.5 metres wide and 2.5 metres high. Most containers carried by aircraft are smaller. Many containers are specially built for one type of freight.

Container ships resemble floating warehouses. Inside the ship's hull, the cargo space is split into a number of huge cells by vertical guide rails. The cells hold the containers which are lowered into the vessel by cranes and stacked one on top of the other. When the cells are full, more containers are loaded onto the deck of the ship in rows. Loading and unloading takes about a fifth of the time it takes to unload a conventional cargo ship. The biggest container ships can carry more than a thousand 6-metre containers.

Special *roll-on/roll-off* ships carry containers on wheels, like a truck trailer. Even larger container vessels are planned for the future, as well as further development of container-carrying barges for use on canals and rivers.

History. Before containerization developed in the 1950s, freight was handled several times during transit, especially when being shipped overseas. Factory-packed goods were loaded into a lorry and taken to the railway freight depot. There they were unloaded and

packed into a rail wagon. After the rail journey to the sea port, the freight was unloaded again and reloaded into the hold of a ship. At this time, a general cargo ship had individual holds, or cargo areas. Dockworkers loaded the freight into the holds through hatches. They used mechanical cranes, but also did much of the work by hand.

Dockworkers' trade unions became well organized, campaigning for higher wages and better work conditions. At some ports there were frequent disputes and strikes. Dockworkers at some ports were blamed for so-called restrictive practices, which hindered the introduction of more efficient working methods and led to the decline of trade at these ports.

The transporting of *truck trailers* by rail was the first widely used method of container shipping. The pre-packed container was simply loaded onto the back of a long-bodied truck and driven to the rail yard. There it was offloaded onto a special rail wagon. If the container was destined for overseas, it was lifted from the rail wagon onto a container-carrying ship.

See also *Railway* (Freight trains); *Ship* (General cargo ships; Container ships).

Contempt, in law, is wilful disregard or disobedience of public authority, such as a court or legislative assembly.

Contempt is usually shown by failure to obey specific demands, or by insults. Such acts are intended to challenge or reduce public authority and dignity. There are two kinds of contempt of court: that which is committed in or outside a court, that disturbs or interrupts its proceedings, and that which results from a refusal to comply with an order of the court. The first is known as *criminal contempt*, the second as *civil contempt*. Criminal contempt may be punishable by imprisonment, a fine, or an order to give security for good behaviour. Civil contempt may be punishable by imprisonment, or seizure of the property of the *contemnor* (person in contempt), or a fine.

See also *Attachment*; *Court*; *Crime*; *Trial*.

Continent is a part of the earth's surface that forms one of the great dry-land masses of the world. It usually has extensive plains or plateaus and one or more mountain ranges, and is surrounded or nearly surrounded by water. The continents of the world are Asia (44,009,000 square kilometres); Africa (30,246,000 square kilometres); North America (24,219,000 square kilometres); South America (17,832,000 square kilometres); Antarctica (14,000,000 square kilometres); Europe (10,443,000 square kilometres); and Australia (7,713,300 square kilometres). Technically, Europe is not a continent, but a peninsula of Asia. It is part of what may be called the Eurasian continent, which has a total area of about 54 million square kilometres.

See the articles in *World Book* for each continent. See also *World* (graphs: Facts about the continents).

Continental Congress was a convention of delegates from the American Colonies that first met in Philadelphia, Pennsylvania, on Sept. 5, 1774. The meeting grew out of a desire for unity which had spread through the colonies. All the colonies saw danger to themselves in the acts of the British Parliament aimed against the colony of Massachusetts, especially the Boston Port Bill. This was one of the laws implemented to punish the col-

316 Continental divide

onists for their destruction of tea in Boston harbour in December 1773. See **Boston Tea Party**.

The First Continental Congress was attended by 56 delegates representing 12 colonies. Georgia sent no delegates but agreed to support any plans made at the meeting. The first Congress was more interested in exacting fair treatment from Great Britain than in independence. It set forth the position of the colonies toward taxation and trade in a Declaration of Rights, adopted on Oct. 14, 1774. The Congress recognized that it was not practical for the colonies to seek representation in Parliament. But it claimed the right of each colonial assembly to draw up its laws on all subjects except foreign trade.

Second Continental Congress. British colonial policy did not change, and the colonies drew close to war with the fighting between Massachusetts farmers and English troops at Lexington and Concord. The Second Continental Congress met in Philadelphia on May 10, 1775. The Congress took on the duties of a government, uniting the colonies for the war effort. An army was organized and George Washington was appointed commander in chief. On July 8, 1775, the Congress issued a declaration setting forth the need to take up arms and the reasons for doing so. Two days later, it made a final, futile appeal to the king in an effort to right matters without going to war.

With the outbreak of war, the Second Continental Congress encouraged the colonies to set themselves up as states. On July 4, 1776, it adopted the Declaration of Independence. Then it set about drawing up an outline for a permanent union of states which resulted in the Articles of Confederation. The second Congress operated under great difficulties, because it was a group without legal authority except when it acted with the consent of the states. It continued to work until March 1, 1781, when a Congress authorized by the Articles of Confederation took over. This Congress was known as the *Congress of the Confederation*, but many people continued to use the name Continental Congress for it.

See also **Articles of Confederation**; **Declaration of Independence**.

Continental divide is the term used to designate the line of elevated land that separates areas drained to opposite sides of a continent. In North America it is also called the *Great Divide*, and separates westward-flowing

and eastward-flowing waters (see **Great Divide**). In South America, the continental divide follows the western portion of the Andes Mountains. In Europe, the divide separates streams flowing to the Atlantic and Arctic oceans on the north and to the Mediterranean and Black seas on the south. In Asia, the divide separates drainage into the Arctic and Pacific oceans on the north and east from drainage into the Indian Ocean on the south. The African divide separates drainage into the Atlantic Ocean from drainage into the Indian Ocean. See also **Divide** (diagram).

Continental drift is the name of the theory that says the continents have moved great distances on the earth's surface and are still moving today. In spite of evidence that the continents were moving, scientists could not explain until the 1960's how they moved.

It was oceanographers who found an important clue to the answer. By the middle 1950's, they had mapped a worldwide system of deep oceanic trenches, *island arcs* (curved chains of islands), and mid-oceanic ridges or mountains. *Seismologists* (scientists who study earthquakes) noted that many deep earthquakes occur beneath oceanic trenches. They also observed that volcanic activity and earthquakes are concentrated along lines parallel to the ocean ridges.

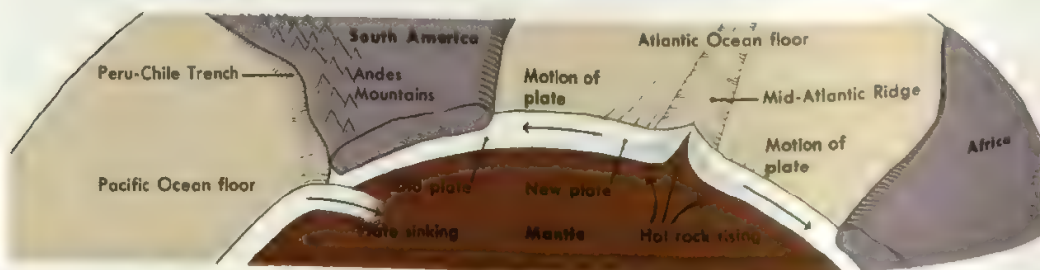
In 1960, H. H. Hess, an American geologist, developed a theory to explain how continents moved. His theory, called *sea-floor spreading*, suggested that convection currents carry molten rock up to the oceanic ridges and force it into large cracks in the ridges. As the molten rock hardens, it pushes the ocean floor and the continents away from the ridges.

The British geophysicists F. J. Vine and D. H. Matthews proved the theory of sea-floor spreading in 1963 by using palaeomagnetic measurements near the oceanic ridges. They based their experiments on two facts: (1) Magnetic particles in the sea-floor rocks recorded the direction of the earth's magnetic field when the rock hardened. (2) The direction of the field reversed itself from time to time as the ocean floor formed. If the sea floor spreads, the patterns of normal and reversed magnetism should match on both sides of the ridge. Their experiments found these matching patterns.

In 1968, the American earth scientists Bryan L. Isacks, Jack E. Oliver, and Lynn R. Sykes proposed a theory that broadened and combined the ideas of sea-floor spread

The continental drift theory

The continents drift because the earth's outer shell consists of large, rigid plates in continual motion. This diagram shows how hot rock rising beneath the Mid-Atlantic Ridge adds material to the plates of South America and Africa. Where two plates meet, the old material is either pulled down into the earth's mantle or pushed up to form mountains. The Peru-Chile Trench and the Andes Mountains were formed by the South American plate and a Pacific Ocean plate.



ing and continental drift. According to their theory, the earth's outer shell, called the *lithosphere*, consists of huge rigid plates that are in continual motion. These plates slide on a soft zone within the earth's mantle called the *asthenosphere*. As the plates move, they carry the ocean floor and the continents with them.

When two plates separate from one another along an oceanic ridge, molten rock from the mantle fills the gap between them and builds up the ocean floor. Something must happen to one of the plates as the newly created ocean floor displaces it. In some areas, a moving plate is pushed downward and melts in the mantle. Oceanic trenches form there, where some of the melted plate rises up to form volcanic island arcs alongside the trenches. In other areas, the edge of the plate crumples and forms large mountain ranges, such as the Alps and the Himalaya. The study of such changes in the earth's surface is called *tectonics*.

See also **Plate tectonics**.

Continental shelf. See Ocean (The land at the bottom of the sea); Earth (Map: Where oceans overflow the land).

Continental System sought to choke off the United Kingdom's (UK) trade with the rest of Europe in the early 1800's. Napoleon I of France adopted it as a means of economic warfare against the UK. Napoleon began the system with his Berlin Decree of Nov. 21, 1806, which declared the UK to be in a state of blockade. His Milan Decree of 1807 extended the blockade to neutral ships that stopped in the UK. Napoleon fought the Peninsular War in a vain effort to enforce the system. But these attempts proved to be a major factor in his losing Russia as an ally. See also **Napoleon I** (Fall from power).

Contour map. See Map (pictures).

Contour ploughing. See Conservation (Soil conservation techniques; pictures).

Contraband, in commerce, means *trade forbidden by law*. The word *contraband* most often refers to goods useful in war, such as arms or ammunition. The warships of a country at war may search for, seize, and destroy contraband goods that are being shipped to its enemy in neutral ships. During World War I (1914-1918), the United Kingdom declared cotton to be contraband, because Germany used it in the manufacture of explosives. During World War II (1939-1945), Germany and the United Kingdom published contraband lists of many items. In more recent times, the illegal trafficking of drugs has increased to such an extent as to become a matter of international concern.

See also **Blockade**.

Contraception. See Birth control.

Contract is an agreement made by two or more persons that is enforceable by law. It consists of voluntary promises to do or not to do certain things. When people make a contract, their promises become legal obligations.

Contracts are vital to the economic systems of countries where private enterprise is encouraged. Much of the wealth of free enterprise nations takes the form of such contracts as bonds and promissory notes. Most business activities in these countries depend on contracts. These contracts include promises to deliver or pay for goods, perform or pay for services, pay wages or rent, exchange property, and construct buildings.

Freely made economic decisions are basic elements of the free enterprise system. As a result, a leading principle of contract law is that persons may agree with each other on any terms they think fit. But an agreement that would upset public order is unenforceable. For example, the courts would not enforce an agreement to bribe a public official. The courts also refuse to enforce an agreement if one party has clearly taken unfair advantage of another. The laws bar some people, chiefly minors or the mentally incompetent, from assuming obligations under contract.

The making of a contract usually involves two important acts: (1) making an offer and (2) accepting the offer. The acts may be verbal or in writing. However, the law requires certain contracts to be made in writing. These contracts include agreements to sell or lease property and, for instance, hire purchase agreements and contracts of employment.

Before a contract is formed, the parties usually negotiate the terms of the agreement. One party makes one or several offers. As soon as the other party accepts an offer, the negotiations are over. Under many systems of law, the moment of acceptance is decisive. At that time, the contract is concluded. Government agencies usually negotiate contracts under special rules. They invite all interested parties to submit *tenders* (offers). Then they accept the most favourable tender.

Most contracts are enforceable only if all parties get something out of the agreement. What a contracting party gets is called *consideration*. When a loan contract is made, the money advanced by the lender is the consideration received by the borrower. The borrower's promise to return the money with interest is the consideration received by the lender. A promise for no consideration is not an offer to make a contract. For example, if two friends promise each other to meet for lunch, no consideration is involved. They merely agree to a social engagement, not to a contract.

A contract is said to be *discharged* after the obligations of the agreement have been fulfilled. If either party violates the agreement, a *breach of contract* occurs. In that case, a court ordinarily awards money, called *damages*, to the other party. In enforcing contracts, the courts try to carry out the plain intention of the agreement.

See also **Bond**; **Lease**.

Contract bridge. See Bridge (card game).

Contractor. See Building trade.

Contrail is a thin line of cloud that forms behind aircraft at high altitudes. Contrails consist of tiny water droplets or ice crystals. They form when water vapour in the air *condenses* (becomes liquid) or *freezes*. Contrails are also called *condensation trails*, *exhaust trails*, or *vapour trails*.

A contrail may form in two ways. (1) The exhaust from an aircraft engine contains water vapour. This vapour may condense when it mixes with cold air around the plane. Contrails last longest in very cold air, and so they are rarely seen when an aircraft takes off or lands. This way is by far the most common. (2) When a plane moves through the air, water vapour may condense in thin clouds over the wings and behind the wing tips and the tips of the propellers. The condensation occurs because the air temperature drops as the pressure drops.



Contrails form behind aircraft at high altitudes. Ice crystals from a contrail may cause precipitation to fall from clouds.

Contrails may have some effect on the weather. For example, ice crystals from a contrail may cause rain or snow to fall from certain clouds. The crystals act like the chemicals used to "seed" clouds in rainmaking operations. See **Rainmaking**.

Contralto is the lowest voice a woman can sing, and falls in the lower register of an alto voice. Some parts in music are written either for a woman singing contralto or for a man singing the same part. He is called a *countertenor*.

Control rod. See **Nuclear reactor** (The control rods; illustration: Parts of a nuclear reactor).

Convection. See **Heat** (How heat travels); **Cloud** (How clouds form).

Convection current. See **Continental drift** (Causes of continental drift).

Convector. See **Heating** (Steam and hot-water heating systems; diagrams).

Convent is a religious community, usually of women, who have taken religious vows and live under religious rule. The term is commonly applied to an order or society of female Christian nuns, and especially to the building in which they live. The head of a convent is usually called a *mother superior*, but may have a different title, such as *abbess* or *prioress*.

The word *convent* comes from the Latin word *conventus*, which means *assembly* or *gathering*. Originally, the word meant any religious house. During the Middle Ages, it was used by the Franciscan order to distinguish its new form of life from the older abbey or monastery forms.

In a *cloistered* convent, the sisters and novices are isolated from the outside world. In their cloistered life, they seek their own salvation and that of others through worship, prayer, and contemplation. The Carmelites and the Poor Clares are contemplative orders. *Uncloistered* convents include orders, societies, and institutes that conduct schools, maintain hospitals, and provide other types of social services. Examples are the Little Sisters of the Poor and the Daughters of Charity. To some degree, almost all orders seek to combine the two ways of life.

Buddhist and Taoist nuns also live in convents. They devote themselves to contemplative lives, but they are not as fully isolated from society as the Christian contemplative orders.

See also **Nun**; **Religious life**; **Monasticism**; **Cloister**.

Convention. See **Political convention**.

Conversion. See **Petroleum** (Refining petroleum).

Converter is a device used to convert electrical energy from alternating current to direct current. An *inverted converter* changes direct current to alternating current. See also **Electric current**.

Convertibility describes a currency which may be freely exchanged for another country's currency or gold. Convertibility plays an important role in international trade. For example, an importer from nation A buying goods from nation B must find a way to pay for them. This is much easier if the two currencies are convertible, because all the importer needs to do is go to the bank and purchase a cheque for an equivalent amount in B's currency. Otherwise, the importer may not be able to buy B's goods if B restricts the availability of its currency. Convertibility exists for the world's major currencies. However, the currencies of China and other Communist nations, and many of the developing countries are inconvertible.

See also **Barter**; **Exchange rate**; **Money** (International finance; table: Exchange rates).

Convertiplane. See **V/STOL**.

Conveyancing is the legal procedure used for transferring *real property* from one owner to another. Real property is property that cannot be moved, such as land and buildings, as distinct from *personal property*. Conveyancing involves both a contract to transfer the property and proof of the *title* (right to possess) the property. Where the legal profession is divided into barristers and solicitors, conveyancing is normally carried out by solicitors. Some countries allow people who are not lawyers to qualify as conveyancers, and buyers or sellers may carry out their own conveyancing if they wish.

The first stage in buying property is for the buyer and the seller to agree on a price. This preliminary agreement is often stated to be *subject to contract*, which means that either party can drop the purchase at any time. A small deposit on the price may be paid by the buyer.

The contract is prepared by the seller. Before signing the contract, the buyer should carry out a thorough inspection of the property and may employ a surveyor to do this. The buyer cannot later back out of the contract if he finds defects that he should have noticed (known as *patent* defects). He may question tenants of the property to check the terms of their tenancies. He may question the seller about boundaries to the property, restrictions on the land, or *easements* (the right to use the land to gain access to another property); and he may ask about outgoings, such as insurance. If the seller knowingly gives him incorrect information which the buyer relies upon to make his decision, the buyer may be able to *rescind* (cancel) the contract later. The buyer must also question the local authority about any planning restrictions or proposed road or railway schemes affecting the property, and he must search local registers of charges on the land.

The description of the property contained in the contract will be used in the conveyance, so it is important that the property should be described correctly at this stage. Usually, the buyer pays a deposit when the contract is signed. The deposit is forfeited if he causes com-

pletion of the sale not to take place. If the sale is by auction, the bid is the offer and the fall of the auctioneer's hammer is the acceptance.

After signing the contract, the seller prepares the *abstract of title* and delivers it to the buyer, according to the contract. The abstract is a summary of the documents showing the seller's title to the property, and the documents referred to in the abstract must be delivered with it. If the land is registered, no abstract is necessary because title will already have been proved and registered. A widely used system of land registration is the *Torrens system*. When the buyer receives the abstract, he prepares a draft conveyance.

After receiving the abstract, the buyer must make a number of final checks before the sale is completed. For instance, he must check that no contract exists to sell the property to someone else. To carry out these checks, the buyer searches the appropriate register. In the case of registered land, an official search is made at the registry. Registered land is conveyed by an *instrument of transfer* and the buyer is registered as the new proprietor.

When the conveyance is agreed, it is *engrossed* (put into a formal document) by the buyer. The seller delivers a *completion statement*, showing the balance of payment due. The balance is paid and possession is transferred. After completion, the buyer is entitled to exercise the rights previously held by the seller, apart from any restrictions agreed in the contract. If mistakes have been made in the conveyance so that it is not a true record of the intentions of the parties, these mistakes may be rectified by a court.

See also **Contract; Easement; Estate; Torrens system.** **Conveyor belt** is a device that *conveys* (carries) large quantities of material from place to place. It consists of an endless belt that is looped over two pulleys. One of the pulleys is called the *drive pulley*, and supplies the power that keeps the belt moving. Most conveyor belts are powered by an electric motor.

The belt travels over a series of rollers that reduce friction and support the belt. The material moves along the belt at a moderate speed in a straight line. A conveyor belt can carry material at a much steeper gradient, or slant, than can a truck or a train. The steepness of the gradient is limited only by the slant at which the material will slide down the belt. Conveyor belts used in mines may be over 1 kilometre in length.

Types of conveyor belts. The belt of a conveyor may be flat and wide, and the materials simply placed on the belt to be carried away. But for moving bulk material, such as sugar or salt, the belt forms a trough so the material can be moved without spilling. Other conveyor belts consist of chains that have buckets hanging from the chain. Some chain belts have either hooks or scoops that pick up the material and carry it from one place to another.

Often, a conveyor belt makes up only a part of a much larger conveyor system. If the conveyor system must change directions or turn a corner, the material is dropped from one belt to another belt that moves in the desired direction.

Uses. Conveyor belts play an important part in mass production. Cars, for example, move along the assembly line on a conveyor system (see **Assembly line**). Workers

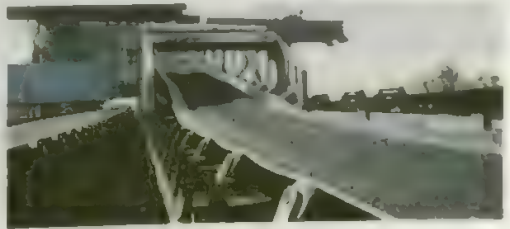
stand in one place, and the materials to be worked on move past them. In airports, conveyor belts carry luggage from the ticket counter to the baggage room. Some buildings now use moving walkways, which consist of a ramplike conveyor belt with handrails. An escalator is a conveyor belt designed to form stairs as it moves around as an endless belt.

Conveyor belts are widely used to load and unload ships, trucks, and railway trucks. One such system moves over 5,400 metric tons of coal an hour in a steady stream from railway trucks to the belt. The belt carries the coal to a loading tower that distributes the coal to the various parts of a ship.

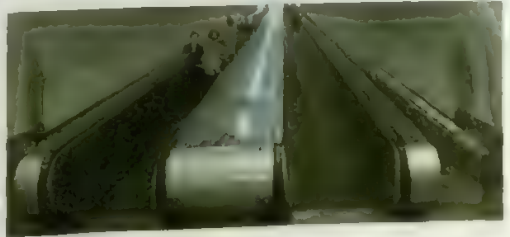
Many industries use special types of conveyor belts to make their products. Large bakeries, for example, use conveyor belts to speed up the baking of bread. The mixed dough is placed in tins and put on an endless belt that passes through a walled oven over 30 metres long. It takes about 30 minutes to carry the tins through the oven. The continuous movement of a number of these belts allows large bakeries to bake over 30,000 loaves of bread an hour.

See also **Car (Henry Ford; diagram: Assembling a car). Escalator.**

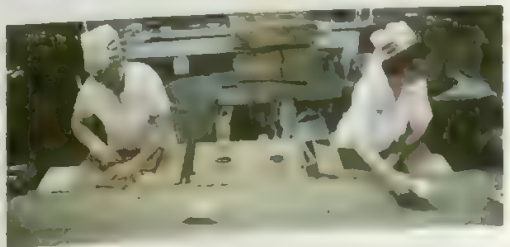
Conveyor belt



Trough conveyor belts are used to move bulk material.



A moving walkway is actually a flat conveyor belt.



A conveyor belt carries cheese along an assembly line.



Convicts breaking rocks to build the first road across the Blue Mountains in 1815 were painted by the visiting American artist Augustus Earle.

Convicts in Australia and their jailers were the earliest European settlers. The convicts lived under a system that was cruel by today's standards. At times, it was harsh even by the standards of the 1700's and early 1800's. Under the convict system, the lash was commonly used for punishment. In remote areas, some prisons, known as *penal settlements*, earned reputations as living hells for the men sent there. A small number of skilled convicts were able to make a success of their lives. But for most convicts, life was harsh and miserable. These unlikely colonists laid the economic foundation of early European settlement in Australia. Without their labour, the wool industry would never have developed, and public buildings, roads, and bridges would not have been constructed.

The prisoners

Transportation. The 1700's were years of change and unrest in Britain. Britain was changed first by the *Agricultural Revolution*—the invention of new farming equipment, better crop-growing methods, and improved methods of breeding animals. Later, people were affected by the *Industrial Revolution*, as many new factories were rapidly established. See *Agriculture* (The Agricultural Revolution) and *Industrial Revolution*.

In country areas, people whose ancestors had lived on the land as tenants were forced to leave. Most went to the cities but found little or no work there. Poverty and drunkenness were widespread. So, too, was crime—particularly against property. There were few

policemen to enforce the law. The police force as it exists today did not develop until the 1800's. Punishments for people caught committing crimes were extremely harsh and included the death penalty and *transportation*—that is, sending the convicted person overseas to one of Britain's colonies.

Transportation was established in 1718, both as a form of punishment for convicted criminals and as a way of providing cheap labour for Britain's American Colonies. On arriving at a colony, the convicts were put to work by ships' masters.

The American Revolution stopped the transportation of convicts to the American colonies. The jails in Britain soon became overcrowded with convicts waiting to be sent overseas. As a temporary measure, the government put the convicts on *hulks*, ships that were no longer seaworthy and from which the masts had been removed. Hulks were first used on the River Thames in London. Conditions in the jails and on the hulks were primitive. For example, they were infested with rats, and diseases were common.

The British government searched for new places that would receive convicts. Several places were considered, including parts of Africa. But Botany Bay, on the southeast coast of Australia, was seen as the best choice. It was a long way from Britain. It did not pose threats to health as the African sites did. Moreover, Sir Joseph Banks, the botanist who had visited Australia with Captain Cook in 1770, had written a glowing account of the place, suggesting that any colony estab-

lished there would quickly become able to grow enough food for its own needs. In 1786, Botany Bay was chosen as the site for a new penal colony.

Between 1787 and 1868, when transportation to Australia ended, about 160,000 convicts were sent to Australia. From 1787 until the end of transportation to New South Wales in the 1840's, about 68,000 men and 12,500 women were sent to that colony. New South Wales at that time included Norfolk Island and present-day Victoria and Queensland. From 1803 to 1853, about 55,000 men and 12,500 women were sent to Van Diemen's Land (now Tasmania). And from 1850 to 1868, almost 10,000 men were transported to Western Australia.

Backgrounds of the convicts. Records kept by authorities show that three out of every four convicts were not married. Their average age was 26. Two out of three were Protestant. About one-third were Roman Catholic. Most of the males were labourers or farm workers. Most of the women gave domestic servant as their occupation. Few convicts could read or write. Convicts transported from Ireland accounted for about 25 per cent of all convicts transported to Australia.

Sentences handed down for transportation ranged from 7 years, to 21 years, to life. Records show that the offences of the convicts included almost every crime in British law. But the overwhelming majority of convicts—about 85 per cent—were transported for crimes against property. These ranged from *petty larceny* (the theft of items of small value) and picking pockets, to forgery, highway robbery, and *embezzlement* (stealing money

placed in one's care). The rest of the convicts were transported for a variety of crimes, including assault, man slaughter, and offences against military or naval discipline. A large proportion of women—at least a third—had been prostitutes and thieves.

During the period of transportation, opinions about the nature of the convicts were mixed. Some people maintained that the convicts were simply evil men and women who lived by crime. According to this view, the convicts were the worst criminals in Britain's cities. Others argued that the convicts had committed crimes because they were poor people who suffered from unemployment, bad housing, and other harsh social conditions of the time. This argument continues today.

Convict ships

The first convicts were taken to Botany Bay. In 1787 the First Fleet, under command of Captain Arthur Phillip left England. The convicts who sailed with Phillip were treated humanely, at least by the standards of the day. They arrived at Botany Bay in 1788. See *First Fleet*.

Convicts who followed in the Second and Third Fleets were not treated as well. The Second Fleet became notorious for its cruelty and the number of deaths that occurred during its voyage from England. The ships that transported convicts to the colonies were chartered by the British Admiralty. London businessmen were then given contracts to take the convicts to Australia. The contractors responsible overcrowded the vessels to make room for cargo to be sold on arrival in Sydney.



The death of a convict on board the hulk *Justice* was depicted by the British artist George Cruikshank in about 1848.

The captains chosen were more interested in the profits to be made in Sydney than the welfare of the convicts. Although enough food had been supplied, convicts were reduced to a starvation diet. They were rarely allowed up on deck to exercise. When the Second Fleet docked in Sydney Harbour in 1790, 267 of the 1,000 convicts had died and another 488 were ill with fever, *dysentery* (an illness affecting the bowels), and *scurvy* (a disease caused by lack of the vitamins contained in fresh fruit and vegetables). Phillip protested to the government, and the subsequent publicity was enough for charges to be brought against some of the men involved. They fled England before they could be brought to trial.

Improvements in the conditions governing convict ships were slow in coming. From 1802, ships' surgeons were paid a bounty for every convict landed in good health, and ships' masters were paid extra if the voyage had been properly conducted. Regulations ensuring that convicts received enough food and fresh air were enforced. Convicts were given clothes, and overcrowding on board was banned. Each convict was allowed 45 centimetres of sleeping space—a substantial improvement on the space previously allotted. Exercise on deck became compulsory. With these improvements, the death rate on convict ships declined. But, from 1787 to 1868, about 3,000 convicts died on the way to Australia.

The convict system

Although Australia was a penal colony, very few convicts served their full sentences in jail. The majority of convicts served most of their sentences under a system known as *assignment*.

Assignment began as a means of employing surplus convict labour. By the 1820s, it had become the major

method of convict organization and control. Convicts were assigned to free settlers, particularly the more wealthy men, who used convict labour for their farms and businesses. In return, the settlers provided their assigned convicts with food, clothing, and shelter. Assignment thus reduced the British government's cost of maintaining the colony. For the masters, it provided a source of cheap labour.

The lives and conditions of assigned convicts varied enormously. Some convicts were assigned to masters who treated them well and offered such incentives as additional rations or tobacco for good behaviour. But many more were assigned to cruel men, who were only interested in getting as much work as possible for the least cost. Convicts had no say in their assignments. And, if allotted to a cruel master, they had little chance to complain to a judge.

Masters were responsible for discipline amongst their convicts and could bring a convict before the magistrates for any misbehaviour or minor crime, either real or imagined. In many cases, the magistrates were masters themselves, and they rarely decided a case against a master. Typical offences recorded against assigned convicts were being drunk and disorderly and being absent without leave. Punishments ranged from flogging—the most common—to time in the iron gangs or in penal settlements for more serious crimes.

During the 1830s, criticism of the assignment system and transportation in general began to surface. In 1839, assignment was abolished.

Probation. In 1842, the British government introduced a new system of convict organisation in Van Diemen's Land to replace assignment. It was called *probation*. On arrival, all convicts were allocated to probation gangs. The gangs were used to build public works, such as roads, bridges, and buildings. With good behaviour and after two years, convicts were issued *probation passes*, which allowed them to work for private employers for wages. Part of their wages were withheld and saved for them.

Continued good behaviour was rewarded by a *ticket of leave*, which freed them of some of the restrictions controlling the pass. Finally, convicts could earn a pardon. Both the pass and ticket could be withdrawn for bad behaviour.

Pardons. The governors of New South Wales and Van Diemen's Land had the power to pardon convicts before their full sentences had been served. Two types of pardons were used. *Absolute pardons* restored the convicts' full rights as British citizens and allowed them to return home. *Conditional pardons* were issued with the condition that the person receiving the pardon could not return to Britain until the time handed down in his or her original sentence had expired. Pardons were issued for a variety of reasons. Good behaviour could earn a pardon. So, too, could services rendered to the government. Governors also used pardons to persuade convicts to inform on their fellows and to deal effectively with the menace of *bushranging* (escaping and living as an outlaw in the bush). Convicts who had been pardoned were called *emancipists*.

Punishment of convicts could be light or severe, and it often depended less on what the convict had done wrong than on the nature of the magistrates and mas-



Penal settlements were established in remote parts of Australia. Convicts who committed serious crimes in Australia were sent to these places, where discipline was severe.

ters and how they felt at the time. Many convicts were punished savagely, particularly in the early years of convict settlement in New South Wales and Van Diemen's Land. Flogging, iron gangs, the treadmill, penal settlements, and hanging were some of the methods of punishment used.

Flogging, an inhumane, cruel form of punishment, was used widely. It was administered with a *cat-o'-nine-tails* (a whip made up of nine pieces of knotted cord). Sentences of up to 200 lashes were not uncommon. Some sentences reached 500, and in rare circumstances, 2,000. Fifty lashes took about four minutes to administer.

The iron gangs were used for men who had committed major crimes. Such men were chained at the ankles and then chained to each other and worked on the roads. They were closely guarded and brutally disciplined. Iron gangs built the roads between Sydney and Bathurst and Sydney and Newcastle in New South Wales, and many of the roads in Van Diemen's Land. The work of the iron gangs was hard and exhausting and rations were small.

Shortly after the establishment of settlement in Sydney Cove, it became apparent that new penal settlements were required as places of secondary punishment for convicts who had committed further crimes after arriving in the colony. These new penal settlements were to be located away from existing settlements, and punishment was to be so severe that it would act as a deterrent. Most places of secondary punishment yielded tales of brutality, cruelty, and barbarism. Port Arthur was an exception. Although the prison was run on lines that are harsh by today's standards, its treatment of prisoners was advanced for its day, and emphasized reform as well as punishment.

Hanging was reserved for major crimes, such as murder and bushranging. But, in the first years of settlement in Sydney, when food supplies were extremely short, hanging was used to discourage the theft of food. In 1788, five men were hanged. Eight men and a woman were hanged in 1799.

Convict life. The nature of their assignment, or the severity of their punishment meant that the convicts' lives could be of very different standards. In the early

years of transportation life was very difficult. Both men and women had to make do with a variety of clothing called *slops*, and at first food was scarce.

But once settlement had been established, convict rations were carefully spelled out in the regulations. During the 1820's, the basic government ration for male convicts was 3 kilograms of beef or 1.8 kilograms of pork, 3 kilograms of flour or wheat meal, 1.3 kilograms of maize meal, and 0.9 kilograms of sugar per week. Fresh vegetables were issued occasionally. Women convicts received two-thirds of the male convicts' ration. Convicts assigned to private masters did not always receive the rations specified in the government regulations. Convicts in iron gangs or places of secondary punishment received even less. The standard meal at Macquarie Harbour, for example, was a coarse porridge called *skilly*.

Convict dress was not standardized until after 1810. The yellow uniform, which became familiar enough in Van Diemen's Land during the 1840's to earn the convicts the name *canaries*, first appeared in New South Wales during the 1820's. Convicts in government service were issued clothing every six months.

Women made up 16 per cent of the total number of convicts sent to the eastern colonies. They were assigned mainly as domestic servants on arrival. Unlike the men few were sent to outlying rural areas.

In both New South Wales and Van Diemen's Land, the government established *female factories* for convict women. The factories served as jails for women convicted of further offences after arrival, as holding centres for women waiting assignment to new masters, and as lying-in places for pregnant convicts. Troublesome convicts had their heads shaved. Women in the factories worked at different jobs, including manufacturing cloth. The factories also earned a reputation as the homes of future brides, particularly for ex-convicts.

Escape and rebellion. Many convicts tried to escape, but most of their attempts failed. The rugged terrain and dense bush, the distance of Australia from other countries, and hostile Aborigines defeated most escapees. The convicts' sense of geography was also often wrong. In 1791, a party of 53 convicts set out westward from Sydney, convinced that China lay beyond the



Iron gangs included convicts who broke the regulations by being drunk, absent without leave, and so on. They worked in chains at such tasks as roadbuilding.

Blue Mountains. The group was never heard from again. A few escaped convicts, including William Buckley, lived with the Aborigines. A few others stowed away on whaling and sealing boats. Some escaped convicts turned to bushranging, especially in Van Diemen's Land. But most runaways were soon caught and were either executed or sent to penal settlements. In New South Wales and Van Diemen's Land in the early years, authorities feared a convict rebellion. Their fears were realized in New South Wales in 1804, when convicts at Castle Hill near Sydney seized weapons and rose in revolt. The revolt was quickly and ruthlessly put down by soldiers. In Van Diemen's Land, bushranger convicts posed a threat serious enough for the governor to put the colony temporarily under military rule.

History

During the early days of settlement, colonial society in New South Wales and Van Diemen's Land was dominated by the numbers of convicts. In the 1810's, convicts made up almost 60 per cent of the population. Even in 1831, convicts accounted for 45 per cent of the population, with ex-convicts adding another 30 per cent. Some critics saw both colonies as vast, open jails populated by criminals or those who had been criminals, and predicted a gloomy future for Australia. They held particular fears for the women convicts and their children.

End of transportation in the east. Although the British government had suspended transportation to New South Wales in 1840, attempts were made to reintroduce the system in the colony over the next 10 years. Such attempts met with fierce opposition from the majority of colonists, particularly from the free immigrants,

whose numbers had risen steadily during the 1830's. Antitransportation leagues were formed, and these leagues campaigned against transportation. In 1848, hostile crowds greeted the convict ships *Hashemy* and *Randolph*, convincing a reluctant British government that the days of transportation to New South Wales were over. Opposition had also grown in Van Diemen's Land, and an antitransportation league established there attracted a large following. Some people argued in favour of continuing transportation, particularly such wealthy landowners as William Charles Wentworth, who was the son of an emancipist. But opposition to transportation had also found supporters in Britain. In 1852, transportation to the eastern colonies was abolished, and the last transport arrived in Hobart in 1853. But transportation continued to Norfolk Island, where it ended in 1855.

Convicts in Western Australia. The convict system in Western Australia bore little resemblance to that in the eastern colonies. It began in 1850 at the request of the Western Australian government and continued until 1868. The Western Australian economy did not develop as quickly as the colonists wished. They thought that convicts could stimulate the economy by building roads and other public works and by providing a cheap source of labour, as they had done in the east. In fact, one of the convicts' first tasks was to build a jail at Fremantle large enough to house themselves.

Convicts were transported to the colony after serving part of their sentences in Britain. On arrival, they were employed on public works, in conditions similar to those that had governed probation in Van Diemen's Land. With good behaviour, convicts received a ticket of



Castle Hill Rising took place in 1804 when Irish convicts on a government farm near Sydney seized firearms. The rising was put down by soldiers.

leave. Further good behaviour earned a conditional pardon, the condition being that the recipient could not return to Britain. The gold rushes in Victoria and New South Wales in the 1850s led to the replacement of the pardon with a conditional release. It prevented the recipient from leaving Western Australia.

The convict legacy. It is impossible to calculate the human cost of transportation. A convict's life was usually a miserable one. Of the 160,000 people transported, only a handful earned a place in the history books. Some people argue that transportation to Australia gave convicts a better life than they would have found in Britain by providing them with the chance to create a new life. But others point to the cruelty of the convict system, which was concerned more with punishment than reform, and argue that any chance of convicts becoming reformed citizens was lost with the lash. The chance to create a new life in the colonies was limited.

Some people argue that the convict period in Australian history shaped the country's character and that the *egalitarianism* (equality) often attributed to Australians, and the notion of *mateship* (comradeship), have their roots in this period. Others disagree, arguing that the free immigrants who came later brought with them concepts of democracy and a free society. But there is no doubt that convicts played a vital role in establishing settlement in New South Wales and Van Diemen's Land. The economies of these colonies were built on cheap convict labour. Such labour was essential for the establishment of various industries, particularly the wool industry. In Western Australia, convict labour revived the colony's economy and put it on a sound footing.

Study aids

Related articles in *World Book* include:

Australia, History of	Greenway, Francis	Phillip, Arthur
Brady, Matthew	Logan, Patrick	Port Arthur
Buckley, William	Lord, Simeon	Queensland
Bushrangers	Macquarie, Lachlan	Redfern, William
Cash, Martin	New South Wales	Reibey (Mary)
Castle Hill Rising	Norfolk Island	Tasmania
Catchpole, Margaret	O'Brien, William	Transportation
Dry, Sir Richard	Smith	Western Australia
First Fleet		

Outline

- I. The prisoners
 - A. Transportation
 - B. Backgrounds of the convicts
- II. Convict ships
- III. The convict system
 - A. Assignment
 - B. Probation
 - C. Pardons
 - D. Punishment
 - E. Convict life
 - F. Escape and rebellion
- IV. History

Questions

- When did transportation begin?
- For what crimes was a man transported?
- What were the hulks?
- What was the work of the iron gangs?
- For what reasons were pardons issued?
- Why was Port Arthur an exceptional prison?
- Why was escape difficult for the convicts?
- What was the weekly government food ration?
- Why did the government build female factories?
- Why did transportation to Western Australia begin in 1850?

Convoy is a group of merchant ships travelling together for defence against enemy attack. In most cases one or more warships protect the convoy. During World War I (1914-1918) and World War II (1939-1945), almost all United States and British merchant ships crossing the Atlantic Ocean travelled in convoys. The convoys protected the ships chiefly from attacks by German submarines, called *U-boats*. The convoy system proved very successful. The United States built many specialized ships for convoy duty and antisubmarine operations (see *Destroyer*). Britain and Canada used warships called *frigates* and *corvettes* (see *Warship* [Frigates]).

See also *World War II* (The Battle of the Atlantic).

Convulsions are involuntary contractions of groups of muscles often accompanied by loss of consciousness. Convulsions originate in the brain and may indicate damage to brain tissue, such as might result from injury, infections, or tumours. Convulsions may also occur during many illnesses. In young children, so-called *febrile* convulsions often accompany fever. Multiple convulsions of unknown cause occur in epilepsy.

Convulsions vary in form and degree. Sometimes the whole body becomes rigid. At other times, the body may twist and turn, and the muscles of the face, legs and arms may twitch. In some types of epilepsy, only one limb, or even just a part of it, may be involved.

A person who has convulsions should be placed on his or her side to prevent choking if vomiting occurs. If the teeth are not tightly clenched, a handkerchief or another soft object may be placed between them to prevent injury to the tongue. A doctor should always be called for a patient with convulsions. Treatment depends on the cause.

See also *Epilepsy*; *First aid* (Convulsion and epileptic seizure).

Conway, William Cardinal (1913-1977), was Roman Catholic archbishop of Armagh, in Northern Ireland, and primate of All Ireland from 1963 to 1977. He was appointed cardinal in 1965. Cardinal Conway wrote several books on religious subjects, including *Problems in Canon Law* (1965), *The Child and the Catechism* (1959), and *Catholic Schools* (1970). He was born in Belfast and educated at Queen's University, Belfast; at St. Patrick's College, Maynooth, County Kildare, in the Republic of Ireland; and in Rome. He was professor of moral theology and canon law at Maynooth from 1942 to 1957.

Conwy. See *Aberconwy*.

Cony. See *Hyrax*.

Cooper Pedy (pop. 2,880) is Australia's largest opal-mining centre. It is located in the Stuart Range in central South Australia, 970 kilometres from Adelaide. The opal-field was discovered in 1915. Mines are at depths of 5 to 30 metres. Cooper Pedy has an average maximum summer temperature of 36 °C, and many residents live in dugouts to escape from the heat. See *Opal*.

Cook, Frederick Albert (1865-1940), an American explorer, claimed he discovered the North Pole in April 1908. His story was questioned when Robert E. Peary returned from a polar expedition in September 1909. Danish scientists investigated and found that Cook could not prove his claims. His claim that he reached the summit of Mount McKinley, Alaska, was also disputed. Cook was imprisoned in 1923 for mail fraud. He was born in Callicoon Depot, New York, U.S.A.

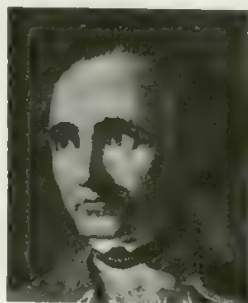


Botany Bay was the site of James Cook's first landing on the eastern coast of Australia on April 29, 1770. Two Aborigines armed with spears fled when the landing party fired a musket.

Cook, James (1728-1779), was a British navigator and one of the world's greatest explorers. He commanded three voyages to the Pacific Ocean and sailed around the world twice. His voyages led to the establishment of colonies throughout the Pacific region by several European nations.

During his historic voyage in *HMS Endeavour*, Cook raised the British flag in New Zealand in 1769. In 1770, he became the first European to visit the eastern coast of Australia. He claimed possession of the land for Great Britain, naming it New South Wales. As a result of his voyage, Australia became a British colony in 1788.

During his three voyages to the Pacific, Cook developed charts that added greatly to knowledge of the geography of the region. A seaman and mapmaker of wide experience, he is rated highly among the world's great maritime explorers. Cook has been called *Columbus of Australia*. His murder by Hawaiian islanders on Feb. 14, 1779 was a great loss to Britain.



James Cook

Early life

James Cook was born on Oct. 27, 1728, in the small village of Marton in Yorkshire, England. He was the second of seven children of a Scottish farm labourer. After a brief elementary education, he became an assistant to a grocer and haberdasher in the coastal village of Staithes. In 1746, he was apprenticed to a firm of ship-owners at Whitby. His new employers were engaged in the coal trade.

In 1755, Great Britain was preparing for war. Cook enlisted in the navy as an ordinary seaman. He displayed considerable skill in surveying and charting the St. Lawrence River. This work played an important part in General James Wolfe's capture of Quebec. It also brought Cook to the notice of the Admiralty, and his report of an eclipse was published by the Royal Society of London.

The first voyage

The transit of Venus. In 1767, the Royal Society was making elaborate preparations to observe a transit of the planet Venus across the sun's face. The transit was to take place in June 1769. King George III took a personal interest in the project. The King ordered the Admiralty to provide a ship to carry the scientific expedition to Tahiti. Cook was promoted to lieutenant and was given command of a ship. This historic voyage to the South



Maoris proved to be a warlike people. Cook first encountered them at Poverty Bay in New Zealand. He went there during his first voyage, on the *Endeavour*.

Seas to observe the transit began his career as an explorer.

The *Endeavour*, a converted collier of 374 metric tons, was bought by the Admiralty for the voyage. By modern standards, the three-masted bark *Endeavour* was unbelievably small for a long voyage through uncharted seas. Its overall length was 32 metres, and its breadth was 9 metres. But its shallow draught made it ideal for coastal exploration. The ship was altered extensively to accommodate the expedition's scientific staff. This included botanist Joseph Banks and the Swedish naturalist Daniel Carl Solander. Together with their assistants, they shared the great cabin. Charles Green was the astronomer.

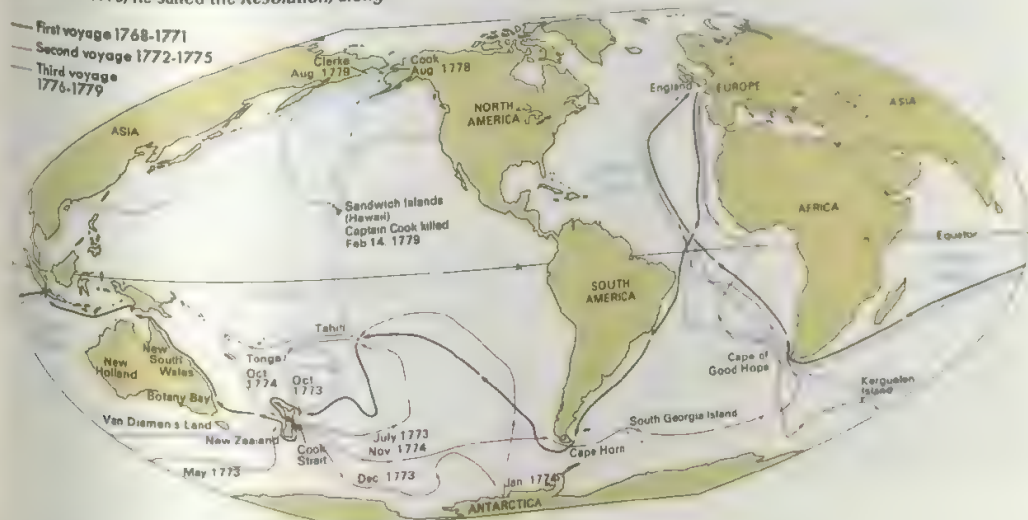
Tahiti was Cook's first destination. The *Endeavour* sailed from Plymouth in August 1768. It had on board 94 people, nearly 18 months' provisions, and 10 carriage guns. Cook travelled by way of Rio de Janeiro and around Cape Horn into the Pacific Ocean. The ship anchored in Matavai Bay, Tahiti, on April 13, 1769. Having observed the transit and explored the island, Cook and his party left Tahiti after a stay of three months. A Tahiti-

an named Tupia sailed with them and later acted as an interpreter among the Maoris.

Secret instructions were given to Cook by the Admiralty before he left England. These instructions ordered him to search for an unknown southern continent. Geographers had always believed such a continent must exist to balance the world. Cook sailed south. But after he reached a latitude of 40° without finding any land mass, he followed his secret orders. These orders told him to proceed in search of land to the westward 'until you discover it or fall in with the eastern side of the land discovered by Tasman and now named New Zealand'. In 1642, Abel Tasman, a Dutch navigator, became the first European to sight New Zealand.

New Zealand was reached by Cook's expedition in early October 1769. The sailors landed at Poverty Bay. There they first encountered the warlike Maoris. Cook spent four months sailing around the North Island, landing frequently. Maoris at Queen Charlotte Sound proved less hostile. But the Englishmen were shocked to find that they were cannibals, and that they preserved their enemies' heads as trophies.

James Cook made three round-the-world voyages. In 1770, he sailed the *Endeavour* along the entire eastern coast of Australia, which he called New South Wales. From 1772 to 1775, he sailed the *Resolution* to New Zealand and Antarctica. And, in 1776, he sailed the *Resolution*, along with the *Discovery*, to Hawaii. Cook was killed in Hawaii in 1779.



Cook then circled the South Island, proving New Zealand to be two large islands, and not part of a southern continent. He sailed around both islands in six months. Experts have marvelled at Cook's speed and thoroughness in surveying New Zealand.

Australian exploration. Cook set a westerly course from New Zealand. He intended to pick up Tasman's route where the Dutch navigator left Van Diemen's Land (now Tasmania). But a southerly gale drove the *Endeavour* towards the then unknown east coast of Australia. Early in the morning of April 20, 1770, the officer on watch, Zachary Hicks, sighted land. This sighting occurred near the present border of Victoria and New South Wales. Cook named the spot Point Hicks. Turning north, he proceeded to chart and name the main features along Australia's eastern seaboard. Later, he called the whole area of land New South Wales because he thought it looked like the shore of Wales.

Botany Bay was the site of Cook's first landing. Strong surf prevented a landing near Wollongong, and the *Endeavour* continued north until Cook found anchorage in a sheltered bay on April 29. Boats were launched, and the landing party rowed towards a group of Aborigines, whom Cook called *Indians*. According to tradition, the first sailor to jump ashore was Midshipman Isaac Smith, a young cousin of Cook's wife. Most of the Aborigines ran off. But two men, as Cook remarked, "seemed resolved to oppose our landing. I ordered the boats to lay upon their oars, in order to speak to them; but this was to little purpose, for neither us nor Tupia could understand one word they said." When the Aborigines hurled spears at the sailors, Cook fired several musket shots, causing them to run away. Captain Cook's landing place, now known as Kurnell, is a public reserve on the south side of Botany Bay. It has a museum and



Aborigines were recorded by the artist Sydney Parkinson on Cook's first voyage to Australia in 1770.

monuments recalling its historical significance.

The *Endeavour* remained in the bay for eight days. The Aborigines gave little trouble, but would not allow Cook's men to come near them. The sailors gathered oysters and mussels, and caught many fish, including giant sting rays. The botanists, Banks and Solander, were delighted to find themselves among strange, new vegetation quite unknown to science. They collected



The *Endeavour* was a *berk*, a small, three-masted vessel without a mizzen topsail. Cook described it as "a good roader [that] careens easy and without the least danger."

excitedly and took their finds aboard the *Endeavour* to be sketched, classified, and preserved.

Cook's first name for the bay was Sting Rays Harbour, but the botanists' discoveries caused him to change it to Botany Bay. In addition, he called the two headlands Cape Banks and Point Solander.

Each day, the British flag was flown at the landing place. A sailor, Forby Sutherland, died while the *Endeavour* was in the bay and was buried nearby. He was the first British person to be buried in New South Wales. Point Sutherland was named after him.

In his description of the land around Botany Bay, Cook remarked on the "deep black soil, which we thought was capable of producing any kind of grain." Stocks of fresh water and firewood were replenished, and the *Endeavour* resumed its northward voyage on May 7. The first Englishmen, in their strange, birdlike vessel, had come to Botany Bay, and had left again. The Australian Aborigines did not see Europeans again for almost 18 years, when Captain Arthur Phillip's First Fleet arrived in January 1788 to establish a prison colony.

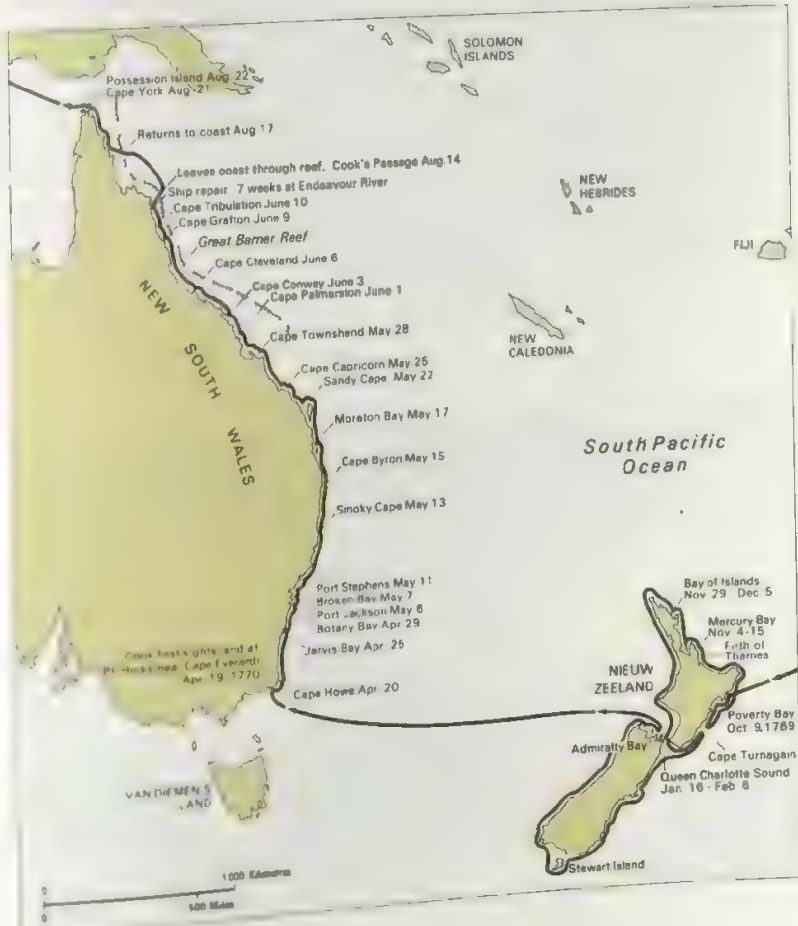
The survey of the east coast of Australia continued. Cook named Port Jackson after his friend George Jackson of the Admiralty. If he had taken time to explore it, he would have found what Captain Phillip later described as "the finest harbour in the world."

Cook also named Broken Bay; Port Stephens, after another Admiralty official, Philip Stephens; Cape Hawke, after Admiral Edward Hawke; Smoky Cape, after smoke from an Aboriginal fire; Cape Byron, after Captain John Byron, grandfather of the poet; and Point Danger, near the present border of New South Wales and Queensland. He noted and named Cape Morton and Morton's Bay after the Earl of Morton, but the editor of his journal misspelt the name as Moreton, and the incorrect form was retained. He also observed Queensland's Glass House Mountains, which reminded him of the tall glass furnaces in his native Yorkshire. Other names on Cook's charts reflect incidents, prevailing conditions, and even his state of mind. Examples include Bustard Bay, Cape Tribulation, Thirsty Sound, Weary Bay, Providential Channel, and Cape Flattery. Cook went ashore at intervals to examine the country and replenish the *Endeavour's* water supply. North of Bundaberg is a memorial to the first European landing in Queensland.

The Great Barrier Reef proved difficult for Cook's small ship to sail through. Nosing carefully around the shoals and islands off the Queensland coast, the explorers often found it necessary to send a boat ahead to take soundings. After navigating and naming Whitsunday Passage, Cook believed that his compass was disturbed by Magnetic Island, off Townsville.

Captain Cook sailed right round New Zealand (now New Zealand) in late 1769 and early 1770. He sailed the *Endeavour* westward until, according to his journal, land was sighted on April 19, 1770 (actually April 20). Cook named the place Point Hicks. Historians assume that this was at or near the point of land later named Cape Everard. Cook went on to chart the entire eastern coast of Australia, which he named *New South Wales*. He raised the British flag on Possession Island and claimed for England all the land he had discovered.

The dates shown on this map are the actual dates in Cook's journal, and are uncorrected for longitude.



On June 11, in the vicinity of Endeavour Reef, the ship ran aground during a clear, moonlit night. The coral made a hole in the ship, and it began taking water. To lighten the ship, the crew threw guns, ballast, and stores overboard. The crew plugged the leak temporarily, and refloated the *Endeavour* by pumping. The ship was then beached for repairs at a spot Cook called Endeavour River. It is now the site of Cooktown. The guns that they threw overboard remained where they sank until 1969, when they were recovered from the coral and restored.

Cook's party stayed six weeks at Endeavour River while repairing the ship. This delay enabled the naturalists to continue their studies of the new land. They saw their first kangaroo and learned its name from the local Aborigines. Banks commented "much to our surprise . . . instead of going upon all fours this animal went only upon two legs, making vast bounds." An opossum with two young was also caught, and a sailor swore that he had seen the devil "as large as a one gallon keg [with] horns and wings"—a flying fox.

Banks thought the Endeavour River Aborigines were extremely primitive. They painted their naked bodies and wore bones through their noses. He described them as chocolate-coloured. But, because they had all their front teeth, he wondered whether they were the same people that William Dampier had seen on his visits to Australia (then called New Holland) one hundred years earlier.

After a thorough overhaul, the *Endeavour* put to sea. This time the ship managed to get outside the Barrier Reef through Cook's Passage. Then, anxious to discover whether the mainland joined New Guinea, Cook again negotiated the reef through Providential Channel. He named the northernmost point of the coast Cape York, after the Duke of York.

Possession Island, near Cape York, was where Cook went ashore and hoisted the British flag. "Possession was taken in his Majesty's name and under his colours" to the accompaniment of cheers and volleys of musketry. Cook's name for the land he had been charting since Lieutenant Hicks first sighted it on April 20 was New South Wales.

The voyage home began once this historic ceremony was over. Cook sailed through Torres Strait, heading for Batavia (Jakarta). The *Endeavour* remained at Batavia for almost three months, refitting for the long trip to England. Batavia was an unhealthy port, and a number of Cook's party died there. Others died and were buried at sea on the way to Capetown. The ship finally reached England in July 1771.

Cook's achievements during his three-year voyage were many and varied. Apart from the main purpose of the expedition—taking the scientists to Tahiti—he had accurately mapped the coasts of New Zealand and eastern Australia. He had proven that Australia and New Guinea were separated by water. He had also protected his crew from the disease of scurvy. Not least of all, his navigation in the South Pacific raised doubts about the existence of a great southern continent. The published account of his travels, translated into many languages, made him known throughout the world.

The second voyage

Cook, now a commander, was determined to find out whether or not a southern continent really existed. He outfitted two ships, the *Resolution* and the *Adventure*. Captain Tobias Furneaux commanded the *Adventure*.

The expedition left England in July 1772. After calling at Capetown, they sailed south. The weather grew colder, and the crews were issued special warm clothing. A great sea of ice blocked further progress. The ships set an easterly course and became separated. Cook had foreseen this possibility and had arranged meeting places in advance. He sailed the *Resolution* to New Zealand, where he found the *Adventure* awaiting him in Queen Charlotte Sound. Furneaux had arrived there by way of Van Diemen's Land, wrongly assuming that it formed part of the Australian mainland. The Furneaux group of islands at the eastern end of Bass Strait are named after the *Adventure's* captain. The *Resolution* then cruised the South Pacific extensively, visiting Tahiti, Tonga, Easter Island, the Marquesas, the New Hebrides, and New Caledonia. On Oct. 10, 1774, Cook landed on Norfolk Island, then uninhabited.



Ice islands were painted by William Hodges on Cook's second voyage. Cook was the first man to cross the Antarctic Circle.

During Cook's search for the supposed southern continent, he became the first man to cross the Antarctic Circle. He returned to England by way of Cape Horn. The King received him warmly and promoted him to the rank of captain.

The third voyage

The revolution in Britain's American colonies prompted the Admiralty to look for a northern sea route through the Arctic from the Pacific to the Atlantic Ocean. When Lord Sandwich told Cook about this plan, Cook volunteered to lead the expedition. His offer was promptly accepted.

The *Resolution*, commanded by Cook, left England on July 12, 1776. A second ship, the *Discovery*, was under the command of Charles Clerke. After rounding the Cape of Good Hope, the ships headed for Adventure Bay, Van Diemen's Land. They arrived there in January 1777. Cook established friendly contact with the Tasmanian Aborigines before proceeding to his old anchorage in Queen Charlotte Sound, New Zealand. He then visited Tonga and Tahiti. In January 1778, Cook reached the Hawaiian Islands. He named them the Sandwich Islands in honour of Lord Sandwich. From there, he sailed up the west coast of America. In spite of bad weather, Cook continued around the Aleutian Islands and through the Bering Strait. Pack ice finally halted his progress.

Cook decided to spend the winter in Hawaii. The decision proved to be a fatal one. On Feb. 14, 1779, while attempting to recover a stolen boat in Kealahou Bay, he turned his back on some of the islanders, and they killed him.

Clerke took command of the expedition. He tried again to force the northwest passage, but was once more defeated by ice. Clerke died of consumption before the ships reached England in October 1780.

Life on Cook's ships

By today's standards, Cook's ships were quite small, with little headroom between decks. Life aboard was cramped. Officers enjoyed the comparative comfort of a cabin, but the sailors took their meals and slung their hammocks in an open space amidships. They were rough, uneducated men, who cursed and swore a great deal. One of the scientists who sailed with Cook was horrified by "the dreadful energy of their language."

Crewmen wore a coarse uniform of jacket, breeches, and linen shirt. Officers wore more stylish uniforms. Their coats had white cuffs and narrow lapels to the waist. Their waistcoats and breeches were also white.

Navy discipline was strict, and flogging was a common punishment. Tobacco was popular with British sailors. Most of them chewed it, but some smoked clay pipes. The men were a hard-drinking lot. They grumbled if they had to drink water, but when supplies of alcohol ran out they had little choice.

Salted beef or pork and ships' biscuits were regular fare, supplemented by suet, peas, cheese, and porridge. Often the biscuits were full of weevils. Banks said, "I have seen hundreds, nay, thousands, shaken out of a single biscuit." Whenever the sailors could catch fish, as they did in Botany Bay, they relished them. John Thomson was the *Endeavour's* cook.

Captain Cook took pride in never having lost a mem-

ber of his crew to that dreaded disease of sailors, scurvy. This was a remarkable achievement in his day. No one knew what caused scurvy. The navy experimented with various preventive measures, including malt, and later, lime juice. On the *Endeavour*, Cook ordered that the crew should be served *sauerkraut* (pickled cabbage). Although the men at first refused to eat it, they quickly changed their minds when they heard it was a favourite dish at the captain's table.

Personal life

Someone who knew Captain Cook intimately wrote of him: "His person was six feet high, and although a good looking man he was plain both in dress and appearance. His head was small, his hair, which was dark brown, he wore tied behind. His face was full of expression, his nose exceedingly well-shaped, his eyes, which were small and of a brown cast, were quick and piercing, his eyebrows prominent, which gave his countenance . . . an air of austerity." Cook was a friendly man. He treated his men in a benevolent and humane fashion, although a crisis could arouse him. At such a time, a shocked botanist remarked, "I should have preferred to hear fewer 'Goddams' from the officers and particularly the Captain, who, while the danger lasted, stamped about the deck and grew hoarse with shouting."

James Cook married Elizabeth Batts in December 1762. Of their six children, three died in infancy. Cook's widow lived to be 93. The sale of her husband's books brought her considerable wealth.

Study Aids

Related articles in *World Book* include:

Australia, History of
Banks, Sir Joseph
Botany Bay
Captain Cook's Cottage
Hicks, Zachary

New Zealand, History of
Queensland
Solander, Daniel Charles
Tasman, Abel Janszoon

Outline

I. Early life

II. The first voyage

- A. The transit of Venus
- B. The *Endeavour*
- C. Tahiti
- D. Secret instructions
- E. New Zealand
- F. Australian exploration
- G. Botany Bay

III. The second voyage

IV. The third voyage

V. Life on Cook's ships

VI. Personal life

H. The survey of the east coast

- I. The Great Barrier Reef
- J. Possession Island
- K. The voyage home
- L. Cook's achievements

Questions

How did Cook play an important part in the capture of Quebec?
What was the purpose of Cook's first voyage to the South Seas?
What were his secret instructions on that voyage?
Why did Cook choose the name New South Wales for eastern Australia?

What was the name of Cook's ship on his first voyage?
What did Cook hope to discover on his second voyage?
How did Cook protect his men from the disease of scurvy?
What name did Cook give to the Hawaiian Islands? Why?
Why did Cook sail as far north as the Bering Sea on his third voyage?
Where was Cook killed?

Cook, Sir Joseph (1860-1947), was prime minister of Australia in 1913 and 1914. He left politics in 1921 and served as Australian high commissioner in London until he retired in 1927.

Cook was born in Silverdale, Staffordshire, England. He began work in a coal mine at the age of 9. He emigrated to Australia in 1885. In 1891, he was elected to the Legislative Assembly of New South Wales as Labour member for Hartley.

Cook, Mount. See Mount Cook.

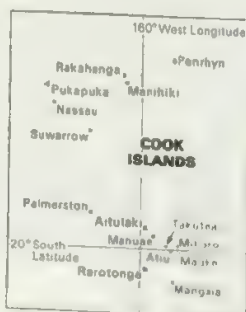
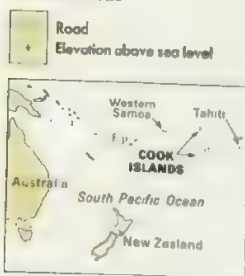
Cook, Thomas (1808-1892), a British businessman, founded the worldwide tourist service of Thomas Cook and Son. Cook was born in Melbourne, Derbyshire, England, and became an evangelist and temperance advocate. In 1841, he organized a train excursion from Leicester to Loughborough and back for a fare of one shilling (5p). He organized other trips by train and steamer. He arranged for 165,000 people to travel to London for the Great Exhibition of 1851. His firm was commissioned to handle General Gordon's expedition to Sudan in 1884. It transported 11,000 British troops and 7,000 Egyptian troops.

Cook Islands lie in the South Pacific Ocean, about 2,900 kilometres northeast of New Zealand. The 15 islands of the Cook group are spread out over 2.2 million square kilometres of ocean. They have a total land area of 240 square kilometres and a total coastline of 145 kilometres. Apart from the atoll of Manuae, the islands are all raised volcanic islands.

The Cook Islanders, who are Polynesians, call themselves *Maoris*. Their language is closely related to that of the New Zealand Maoris, as are their social organization and many of their customs. Cook Islanders also speak English. The Cook Islands have a population of about 17,000, including about 600 Europeans. About 9,500 people live on Rarotonga, 2,300 on Aitutaki, 1,300 on Mangaia, and 1,200 on Atiu. The only large settlement, Avarua, on Rarotonga, is the administrative and commercial centre for the country. Apart from Manuae, Suvarrow, and Takutea, all the Cook Islands are permanently occupied. Most Cook Islanders live in villages.

Traditionally, the Cook Islands' economy has been based on agriculture. Many islanders are engaged in the production of citrus fruits, pineapples, bananas, *copra* (the dried meat of the coconut), and cash crops. In the northern islands, divers collect mother-of-pearl shell. On Rarotonga, there are three clothing factories. Other factories produce local handicrafts. A canning factory processes oranges, pineapples, and other tropical fruits for sale in New Zealand.

Cook Islands



In 1773, Captain James Cook became the first known European to reach the islands. The United Kingdom took control of the islands in 1888, and gave administrative control to New Zealand in 1891. A new constitution gave the islanders control of their internal affairs in 1965. Today, the islands have an arrangement with New Zealand called *free association*. Under free association, the islands are self-governing, the people are citizens of New Zealand, and New Zealand offers the islands military support for defence.

Cooke, William F. See Telegraph (Development of the telegraph).

Cooker is an appliance that provides heat for cooking. A cooker has a hob with several heating areas, and one or two ovens. There are two main kinds of cookers in industrial countries: (1) electric and (2) gas. Other cookers use wood, coal, coke, or oil as fuel.

Electric cookers have *heating units*, in which an electric current generates heat. Most electric cookers have as many as four circular heating units on the hob and one or two rectangular units in each oven. In some cookers, the heating units are placed under a smooth ceramic surface.

Most heating units have an outer surface that consists of a metal tube in two parts. Each part has a spiral shape and encloses a coil of wire. Electricity passes through the coil and heats the coil and the metal tube. An insulating material prevents electricity in the coil from reaching the surface of the tube.

The amount of heat produced by a heating unit can be regulated easily. Some hob units have controls that regulate which one of two possible voltages of electricity is supplied to the coil. The coil becomes hotter at the higher voltage. Controls may also regulate whether both of the coils heat up or whether only one heats up. Another kind of hob unit control turns the current on and off at intervals that vary with the heat desired. The longer the current flows through the unit, the higher the heat.

Most oven units are regulated by *thermostats*, which are devices that keep the unit at a certain temperature, and some hob units also have thermostatic controls (see *Thermostat*).

Gas cookers have *burners* on the hob and in each oven. A burner mixes air with natural gas, synthetic natural gas, or *LP-gas* (liquefied petroleum gas). The resulting mixture flows through small holes in the burner. The mixture is ignited by a spark produced by a built-in electric device, or by a *pilot light* near the burner. A pilot light is a small flame that burns continuously.





Modern cookers use gas or electricity. The gas cooker in the top picture has burners on the hob and an oven below. The electric cooker shown above has four heating units covered by a smooth surface. It also has two ovens.

The heat produced by a burner depends mainly on the amount of gas flowing to the burner. A valve regulates the gas flow to each burner. Hand-operated valves control most burners. Thermostats operate the valves of most oven burners and some hob burners.

History. People in northern China used earthenware stoves for heating as early as the 700's. Wealthy Europeans began to use such stoves in the 1400's.

The first stoves were little more than cast-iron boxes with lids. The American statesman and inventor Benjamin Franklin developed the Franklin stove in the early 1740's. This stove, a cast-iron enclosure, fitted into a fireplace. The first practical cooking stove was designed in the 1790's by Benjamin Thompson, Count Rumford, a British statesman and inventor. This stove, a boxlike brick structure, had holes in the top to hold pots.

Until the early 1800's, most people in industrial countries used fires for cooking and heating. During the 1830's, advances in ironmaking and transportation made cast iron widely available. As a result, iron cooking stoves and heating stoves became increasingly popular. Most of these early stoves burned wood. The first practical coal stove, called a *baseburner*, was patented in 1833 by Jordan L. Mott, an American inventor. In 1855, Robert W. Bunsen, a German chemist, invented the first practical gas burner. In the 1860's, cookers based on Bunsen's burner became popular in cities that had gas piped into

homes for use in gaslights. People who lived in rural areas began to use gas cookers after 1910, when gas became available in pressurized containers.

In many developing countries, people living in rural areas still use traditional methods, such as open fires with wood or animal dung as fuel, to cook their food. In the Indian subcontinent, many villagers cook in clay ovens that are dug into the earth.

Electric cookers were first sold in 1909. Early electric cookers cooked extremely slowly, and few people bought them. After the modern cooking unit was developed in 1930, electric cookers became popular.

In 1922, the Swedish physicist, Gustaf Dalen, invented an energy-efficient cast-iron cooker. This worked on the principle of storing heat and provided heating. It had one warm and one hot plate, and one warm and one hot oven. Cast-iron cookers are still popular today. They can run on electricity, solid fuel, gas, or oil.

Microwave ovens were introduced in the mid-1950's. Microwave ovens heat food by using radio waves that penetrate the food and vibrate its molecules (see **Microwave oven**).

In the early 1980's, sales of *convection*, or *hot-air*, ovens increased. Such ovens, which may be either electric or gas, have blowers that circulate hot air around the food. The ovens cook faster, more evenly, and at a lower temperature than regular ovens.

Solar cookers are being developed to save on fuel costs. The most successful is the *sun basket*. It is a concave vessel, made from bamboo or similar material, covered with plaster of Paris. It is lined with aluminium foil or other reflective material and works by concentrating the sun's rays onto a pot suspended from a tripod.



Stoves of the past. A cast-iron cooker of the late 1800's burned coal, coke, or wood. A 1925 gas cooker had an oven next to the hob. A "potbelly" baseburner of the late 1800's burned hard coal.



Cooking is a basic household activity that can also be an enjoyable pastime. Skilful cooks take great care and pleasure in planning and preparing good meals, *left*. They serve foods that are attractive, tasty, and nutritious. An appealing, nourishing meal, *right*, includes a variety of foods that have contrasting colours, textures, flavours, and temperatures.

Cooking is the preparation of food for eating. Cooking makes food more appetizing and easier to digest. In most cooking, food is heated. But preparation of food such as sandwiches and salads involves no heating. Many people enjoy cooking as a pastime.

Most people can prepare such simple foods as hard-boiled eggs or a green salad without written directions. But many foods, including breads, casseroles, and sauces, turn out best if they are prepared according to a recipe. Numerous cookbooks with a wide variety of recipes are available. Recipes also appear on some food packages and in many magazines and newspapers.

This article discusses basic principles of planning meals and preparing food. Some cookbooks give general tips on both techniques in addition to providing recipes. A beginner should first try simple meals and recipes and then go on to more difficult ones.

Planning meals

Meal planning involves several factors. The food should be nutritious and appealing, and its cost must be within a person's budget. The cook also must consider the time required to prepare meals so they can be planned around a busy schedule if necessary.

Planning nutritious meals requires a basic knowledge of the body's nutritional requirements and the nutrients in different foods. Nutritionists divide foods into basic groups and recommend a certain number of daily servings from each group. The *Nutrition* article describes these food groups and lists the recommended number of servings.

Planning appealing meals. An appealing meal includes foods that have contrasting colours, textures, flavours, and temperatures. The selection of vegetables and fruit can be especially important in adding colour to a meal. The textures of solid foods range from soft to

crunchy, and a meal can include foods that vary in chewiness. Also, a food with a strong flavour may be served with weaker-flavoured ones.

Planning economical meals. There are many ways to save money on food and still provide nutritious, tasty meals. Shoppers can watch for reduced prices on food, buy fresh produce only when it is in season, and select less expensive brands of food. In many cases, lower-priced foods can be substituted for higher-priced ones.

Planning time-saving meals. Lack of time means that some people have to plan meals that do not require much preparation. *Convenience foods*, which include tinned foods, frozen foods, and precooked meals, require little or no preparation. However, some convenience foods cost more than the basic ingredients that would be used to prepare them. Time can also be saved by serving uncooked fruit and vegetables.

Methods of cooking

The basic methods of cooking include (1) baking, (2) roasting, (3) grilling, (4) frying, (5) boiling, (6) simmering, and (7) steaming. While a food is cooking seasonings, such as salt, pepper, spices, and garlic may be added to improve its flavour. Certain foods, called *garnishes*, may be used to make a dish more attractive. They usually are arranged around the food after it has been cooked and before it is served. Common garnishes include parsley, coriander, pickles, chutney, tomato slices, and lemon wedges.

Baking. Food is baked by placing it in a dish in an oven. In most cases, the temperature of the oven ranges from 150° to 220° C. The word *baking* usually refers to the cooking of foods made from a batter or dough. Such foods include breads, cakes, and pies and other pastries. However, casseroles, a few vegetables and fruit and some cuts of meat are also baked.

Roasting. The word *roasting* is used to describe the cooking of certain kinds of meat in an open dish in the oven. For example, a turkey or a leg of lamb is roasted. The meat is placed on a rack in a shallow dish and usually cooked uncovered in an oven. The roasting temperature usually ranges from 150° to 180° C.

Grilling is used mainly to cook meat, but a few kinds of vegetables and fruit are sometimes grilled. The food is placed on a rack directly below or above a continuous source of heat. In *barbecuing*, the cooking takes place over hot coals.

Frying involves heating food in fat, such as butter or vegetable oil, at a temperature of about 190° C. Frying adds calories to food because the food absorbs some of the fat in the pan.

There are three main methods of frying: (1) deep frying, (2) shallow frying, and (3) stir-frying. In deep frying, a large amount of fat is heated in a heavy saucepan or a deep-fat fryer, and the food is immersed in the fat. Deep frying is a popular way of cooking chicken pieces, and potatoes (as chips or French fries). In shallow frying, the food is cooked in a small amount of fat in a frying pan. Eggs, fish, and red meat are often shallow-fried. Stir-frying is an Eastern method of cooking meats and vegetables in a *wok*, a large, thin metal pan with a round bottom. The meat and vegetables are cut into small pieces and cooked in an extremely small amount of fat. The food is fried at a high temperature for only a few minutes and must be stirred constantly.

Boiling is the heating of food in boiling water, which has a temperature of about 100° C. It is a common method of cooking vegetables and rice. The vegetables are boiled in a saucepan over a burner.

Simmering is the heating of food in water or other liquid that is kept just below boiling point. Such food as eggs, legumes, and meat should be simmered rather than boiled. Covered saucepans or *slow cookers* can be used to simmer food. Slow cookers are electric appliances that simmer food in liquid at low temperatures for up to 10 hours.

Steaming is used mostly to cook vegetables. The vegetables are placed on a rack in a saucepan, and water is added. The water should reach below the level of the rack. The saucepan is covered and heated so that the water boils and forms steam, which surrounds and cooks the vegetables. Steaming takes less time than boiling, and steamed vegetables retain a greater amount of certain nutrients than boiled vegetables do. Fish can also be steamed.

Other methods. Some food that requires a long time to cook, such as stews and dried beans, may be prepared more quickly in a *pressure cooker*. This utensil cooks food at high temperatures by means of steam under pressure. Pressure cookers are also called *pressure saucepans*.

Another fast method of cooking uses *microwaves* (short radio waves). Microwave ovens heat foods much faster than gas or electric ovens do. They are especially useful for defrosting frozen foods and heating soups and vegetables (see *Microwave oven*).

History

No one knows when or how people began to cook. Prehistoric people learned to make fire about 1½ million

years ago and probably cooked food over small open fires. But even before they made fire, prehistoric people may have grilled meat over burning wood taken from fires that had started naturally.

The ancient Egyptians cooked their food mostly over open fires. They also baked bread in clay ovens heated with burning wood or charcoal. In ancient Rome, people cooked on raised brick hearths. They set large kettles on iron tripods over the fire. The Romans used two kinds of ovens. In one kind, the fire was built inside the oven and allowed to burn until the oven was hot enough for baking. The other type had double walls with a space between them, and a fire was built underneath the oven. The flames and heat circulated in the space between the walls, thus heating the oven without subjecting the food to smoke from the fire.

Until the 1800's, people in Europe used fireplaces for cooking. They heated food in a kettle and cooked meat on a rod called a *spit*. Many towns had public ovens because large numbers of people did not have an oven in their home.

Many fireplaces had built-in ovens. Iron cooking stoves, most of which burned wood, became popular during the early 1800's. The first practical coal-burning stove was patented in 1833. See *Cooker* (History).

Today, most people in industrialized countries use gas or electric cookers or microwave ovens for cooking. As a result of improvements in these and other appliances, cooking today is much easier and faster than ever. Cooking also has been made easier by the introduction of convenience foods.

Related articles in *World Book* include:

Barbecue	Jam and jelly
Beef	Meat
Blanching	Nutrition (Selecting and cooking foods)
Boiling point	
Cooker	Pastry
Food	Pork
Food, Frozen	Restaurant
Food preservation	

Cookstown (pop. 30,883) is a local government district in Northern Ireland. It is an agricultural district, with Lough Neagh forming its eastern boundary. The administrative centre is the town of Cookstown itself, which dates from the 1700's. The surrounding villages include Stewartstown and Pomeroy. Ballyronan, on Lough Neagh, has a marina. Cookstown district's economy depends on mixed farming, dairy products, and the manufacture of bacon products, cement, cheese, and clothes. **Cooley's anaemia.** See *Thalassaemia*.

Coolgardie (pop. 5,615) is an Australian mining town in the eastern goldfields district of Western Australia, about 560 kilometres east of Perth. In 1892, two prospectors discovered gold there and started the Western Australian gold rush. By 1898, Coolgardie had a population of more than 15,000, making it the third largest town in Western Australia at that time. In the late 1980's, many old mines were brought back into production. Tourism is an important industry in Coolgardie.

Coolidge, Calvin (1872-1933), was the 30th president of the United States (1923-1929). Elected vice president in 1920, he became president on August 3, 1923, following the death of President Warren G. Harding. A Republican, Coolidge won election to a full four-year term in 1924.

The Coolidge era was notable for its paradoxical nature. A shy, quiet man, Coolidge stood for a simple way of life. Yet he served as president during the Roaring Twenties, when carefree behaviour was the rule. Furthermore, Coolidge favoured economy, yet he enjoyed great popularity with a spendthrift public that was experiencing a period of general prosperity.

John Calvin Coolidge was born in Plymouth Notch, a village near Woodstock, Vermont, U.S.A. He rose to national notice as governor of Massachusetts (1918-1920). Coolidge chose not to run for president in 1928.

Coolidge tube, another name for X-ray tube. See X rays.

Cooling system. See Air conditioning.

Coonhound. See Black and tan coonhound.

Cooper. See Barrel.

Cooper, Sir Astley Paston (1768-1841), was a British surgeon who pioneered many operations. He gained the Copley Medal of the Royal Society for suggesting a revolutionary operation for the relief of deafness. He was also an authority on arterial surgery and on hernias. He performed an operation for aneurysm by tying the abdominal aorta. Cooper was made a baronet after removing a cyst from King George IV.

Cooper was born at Brooke, in Norfolk. He studied at St. Thomas's Hospital, London, and at Edinburgh. He taught comparative anatomy at the Royal College of Surgeons, London, and was surgeon to the king.

Cooper, Gary (1901-1961), was an American film actor who appeared in more than 90 films. His cowboy roles in such films as *The Virginian* (1929) and *The Westerner* (1940) made him a symbol of the courageous pioneer of the American West. In these and other films, including *Meet John Doe* (1941) and *Friendly Persuasion* (1956), Cooper came to represent the common person fighting evil. He won Academy Awards for performances in *Sergeant York* (1941) and *High Noon* (1952).

Cooper's real name was Frank James Cooper. He was born in Helena, Montana, U.S.A. He first gained fame as a romantic leading man in such films as *A Farewell to Arms* (1932).

Cooper, James Fenimore (1789-1851), was an American novelist and social critic. He is best known for *The Leather-Stocking Tales*, five novels about Natty Bumppo, a frontiersman. The character has other names in the series, including Leatherstocking. In *The Leather-Stocking Tales*, Cooper became the first author to portray seriously American frontier scenes and people. *The Leather-Stocking Tales*, in the order of the hero's life, are *The Deerslayer* (1841), *The Last of the Mohicans* (1826), *The Pathfinder* (1840), *The Pioneers* (1823), and *The Prairie* (1827). These action-filled stories contrast two ways of life. Natty Bumppo and his brave, noble Indian friends live a life of freedom close to nature. The settlers bring civilization and social order to the frontier, but they also selfishly or thoughtlessly misuse the wilderness.



Gary Cooper

Cooper's conservative ideas about society are reflected in many of his writings. His works show his concern for the freedom of individuals and the rights of property owners. Cooper declared that he believed in democracy. But he said he feared that majority rule would bring disorder and injustice. Cooper thought the United States should be governed by a small aristocracy of cultured and public-spirited landowners.

Cooper wrote several nonfiction works criticizing American life. The best known include the essays *A Letter to His Countrymen* (1834) and *The American Democrat* (1838). Cooper's defence of property rights dominates a series of novels called *The Littlepage Manuscripts*. The novels are *Satanstoe* (1845), *The Chainbearer* (1845), and *The Redskins* (1846).

Cooper wrote the first American novel about the sea, *The Pilot* (1823). This novel has a memorable character, Long Tom Coffin, who, like Natty Bumppo, is a humble man who lives close to nature. Cooper also wrote many tales of exciting sea chases.

Cooper was born in Burlington, New Jersey, U.S.A. He was raised in the frontier community of Cooperstown, New York, which was named after his father, William Cooper. *The Pioneers* and *The Deerslayer* are set in the Cooperstown area. Cooper served in the U.S. Navy from 1806 to 1811. He settled in northern New York, intending to become a gentleman farmer.

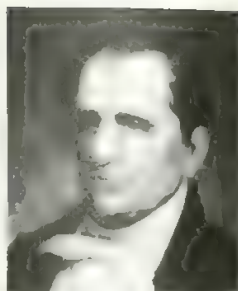
One day, while reading a novel aloud to his wife, Cooper told her he could write a better one. She challenged him to try, so Cooper wrote *Precaution* (1820). This novel received little critical praise. His next novel was *The Spy* (1821), a story about the American Revolution. Its immediate success encouraged Cooper to devote himself to writing.

Cooper, Peter. See Tom Thumb.

Cooper, Susan (1935-), a British author, won the 1976 Newbery Medal for her novel *The Grey King* (1975). This book was the fourth in her series of mystery stories called *The Dark Is Rising*. The stories tell about several British children and their roles in the struggle between the forces of good and evil. The earlier works in the series were *Over Sea, Under Stone* (1966), *The Dark Is Rising* (1973), and *Greenwitch* (1974). The fifth book, *Silver on the Tree* (1977), ended the series. Cooper's other books include *Jethro and the Jumbie* (1979), *Seaward* (1983), *The Silver Cow* (1983), and *The Selkie Girl* (1986).

Cooper was born in Buckinghamshire, England. She moved to the United States in 1963.

Cooper Creek is the southern part of the Barcoo River, below the junction of the Thompson and Barcoo rivers near Windorah, in southwestern Queensland, Australia. Cooper Creek flows southwest from Windorah into South Australia. From there on, it becomes a series of channels and water holes in the salt bed of Lake Eyre. Cooper Creek flows only after heavy rain has



Detail of an oil portrait by Ann Weston Twitthell. The New York Historical Society, New York City

James Fenimore Cooper

Kinds of cooperatives

The chief kinds of cooperatives include (1) supply, or purchasing, cooperatives, (2) marketing cooperatives, (3) housing cooperatives, (4) credit unions, (5) service cooperatives, and (6) worker cooperatives.

Supply, or purchasing, cooperatives are retail stores owned and operated by some or all of their customers. These cooperatives buy goods from farmers, private manufacturers, or wholesalers. By buying in large quantities, they pay reduced prices. They then sell the goods, usually at normal trade prices, to the public as well as to members. Members later receive refund payments based on the amount of their purchases.

The main types of supply cooperatives are *consumer cooperatives* and *farm supply cooperatives*. Consumer cooperatives sell food, household supplies, and other goods. Farm supply cooperatives specialize in farm supplies, such as feed, fertilizer, and seed.

Supply cooperatives have been most successful in the United Kingdom and the Scandinavian countries. During the 1980s, many cooperatives were started in Australia, Britain, and other countries to supply health foods and organic foods, often in bulk quantities.

Marketing cooperatives are groups of farmers who join together to get higher prices for their products. The cooperatives collect, process, sell, and transport the products of their members. Many of these groups have their own canneries, warehouses, and other facilities. They share expensive machinery which an individual farmer would probably not be able to afford alone. This form of cooperative is common in Denmark, France, the Netherlands, Norway, Sweden, the United Kingdom, and the United States. Australia has over 400 agricultural cooperatives. In Canada, most wheat farmers market their crops through large cooperatives called wheat pools. The Saskatchewan Wheat Pool is the world's largest marketing cooperative. In India, cooperatives are on the increase, particularly in rural areas.

In the Soviet Union, cooperative farmers not only share facilities but also hold their land in common and receive shares in the profits according to how much work they do. In Israeli *kibbutzim* (cooperative farm settlements), the land is held collectively and the profits distributed according to the needs of the members.

Housing cooperatives, or housing associations, are owned by people who form a cooperative to buy the buildings in which they live. The shares in the society entitle them to occupy an apartment or house in the cooperative, but they do not actually own their units. The members form a management committee and share maintenance costs. Housing cooperatives are most common in large cities such as London, Melbourne, Sydney, Bombay, and Delhi.

Credit unions are a common type of cooperative in Australia, Canada, and the United States. They are formed by people with a common bond. For example, the members may work for the same company or belong to the same church or trade union. The members of a credit union pool their savings. When one of them has to borrow money, he or she may borrow from the union at a low rate of interest.

Service cooperatives provide many services. Some mutual insurance companies are cooperatives jointly



Cooper Creek is the site of the *dig tree*, where the explorers Burke and Wills found a message to dig for buried food.

fallen in its upper reaches. But with heavy rains, it floods over a wide area, bringing the "dead heart" of Australia to life for a brief period.

Cooperative is a business owned by the people who use its services. Some cooperatives sell goods or services produced by their members. In other cooperatives, farmers or other consumers buy as a group directly from suppliers. By reducing expenses, these organizations often provide lower costs for consumers and higher earnings for producers.

How cooperatives work

Members of the cooperative share equally in controlling the organization. They purchase or earn shares in the cooperative, providing the capital necessary to operate the business. Profits are used to improve the business or are returned to members. The members hold meetings annually to elect directors from among themselves. The directors employ managers to run the day-to-day activities of the cooperative.

Most cooperatives operate under the following general principles. These principles are: (1) The cooperative is open to any person who will use its services and accept the responsibilities of membership. (2) Each member has one vote, regardless of how many shares the member holds. A few cooperatives assign the number of votes according to use of the cooperative. (3) The cooperative pays limited interest on its shares. (4) All profits are returned to members according to how much they use the business. The cooperative usually pays the returns both in cash and in cooperative dividends. (5) The cooperative educates members to help them in making business decisions. It also helps the public understand how cooperatives operate. (6) Cooperatives work together at local, regional, national, and international levels to promote the cooperative movement.

owned and controlled by the people who are insured by them. There are cooperative banks and funeral services. In the United States, electrical cooperatives generate and sell electrical power in rural areas where private power companies cannot make enough profit. Service cooperatives also supply irrigation and telephone service in such areas. Members of a group health cooperative receive medical care for a monthly or yearly fee paid in advance.

Worker cooperatives are factories or other industrial organizations where the employees between them own the company and receive a share in the profits. They have been most successful in Italy, France, and Spain, since the early 1970's. More recently, worker cooperatives have been set up in Australia and the United Kingdom.

Many people regard cooperatives as halfway between capitalism, in which individuals own industry, and socialism, in which the government owns it. In Sweden, which has both private industry and government-owned industry, cooperatives are often called the *middle way*. Other nations with many cooperatives include Finland, France, Iceland, Italy, Switzerland and the United Kingdom.

In North Korea, most farms are cooperatives known as *collective farms*. These farms are controlled by the country's Communist government. Workers on the collective farms receive cash payments and a share of the farms' products. They may also help manage the farms.

History

Most historians trace the beginnings of the modern cooperative movement to the early 1800's. Farmers who wanted more control over the prices they received for their products formed marketing cooperatives. One of the first of these organizations was a cooperative creamery established in 1810 by dairy farmers in Goshen, Connecticut, U.S.A. Farmers also formed purchasing cooperatives, in which they pooled their orders for coal, seed, and other products so they could buy in large quantities.

The first cooperative in Great Britain was the Rochdale Society of Equitable Pioneers, started in 1844 in Toad Lane, Rochdale, Lancashire. The cooperative was set up to provide members with good quality, staple foods at reasonable prices. The organization laid down basic rules, which have been followed in cooperative societies ever since. The first Australian consumer cooperative was set up in 1859 in Brisbane.

The Rochdale society was so successful that as well as paying dividends to its members, it used some of the profits to pay for clubs, libraries, and education for members. Later the Cooperative Wholesale Society (CWS) was started to buy goods from manufacturers and supply them to the cooperative shops. The society also set up its own banking, insurance, and funeral services.

During the 1960's and 1970's, rising prices created an increased interest in consumer cooperatives. In some countries, people formed local cooperatives to save money on groceries. The members took turns buying fruits, vegetables, and other foods from farms or wholesale markets and distributed the items among themselves.

Related articles in *World Book* include
Credit union
Kibbutz
Mutual company
Owen (Robert)

Coorong is a narrow strip of water in the southeast of South Australia. It stretches 88 kilometres from the Murray River mouth to Salt Creek in the south. It is 3.2 kilometres across at its widest point. The Coorong fills the flat area behind the present shoreline dunes, which form Younghusband Peninsula. A channel several hundred metres wide connects the Coorong to the sea. A series of barrages separate the fresh water of Lake Alexandrina from the salty water of the Coorong. The many national parks and sanctuaries in the area ensure the protection of the environment. The most prominent bird in the area is the pelican. See also **South Australia**.

Coot is the name of nine kinds of marsh birds in the rail family. Coots are sometimes called *mud hens* or *marsh hens*.

Coots have black or slate-grey feathers. They range in size from about 33 to 58 centimetres long. Coots have short, rounded wings and a white or yellow bill shaped like a chicken's bill. Fleshy, paddlelike flaps on their toes help them swim.

Coots have prominent *frontal shields*—fleshy backward extensions of the upper bill. The frontal shields are shown to full effect during the male territorial display.

Coots live all over the world except the polar regions. Most coots live in freshwater marshes. They build floating nests from dead plants. The female usually lays 9 or 10 eggs. Coots feed chiefly on algae and the seeds, leaves, and roots of other water plants. They also eat snails, worms, water insects, small fish, and tadpoles. Coots find their food on the surface of the water and on the ground, or they dive underwater to obtain it. Other birds often steal food that coots have obtained by diving.

Scientific classification. Coots belong to the rail family, Rallidae. The European coot is *Fulica atra*. The American coot is *F. americana*.

See also **Rail**.



A European coot nests among waterside vegetation. It is common on lakes, and on flooded sand and gravel pits.

Copeland (pop. 70,700) is a local government district in Cumbria, England. Most of it lies within the Lake District National Park. Whitehaven dates from the 1100's. It was once part of the priory at nearby St. Bees. Near the sea-side resort of Seascale are the nuclear establishments of Calder Hall and Sellafield. Ravenglass is a charming village.

Tourism and agriculture are important in Copeland. Towns such as Millom and Egremont are centres of industry.

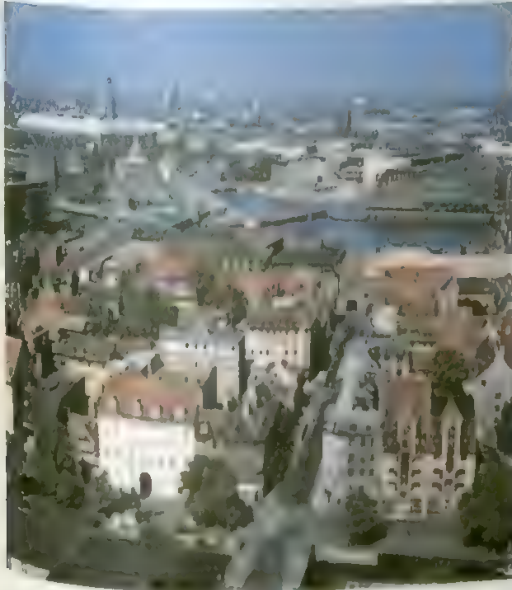
Copeland, William Taylor (1797-1868), was head of the Spode pottery works in central England. He employed leading artists and sculptors to design the popular groups and statuettes that his factory produced. Copeland invented a filter press for working clay. With his partner, Thomas Garrett, he developed a substance called *Parian*, an imitation marble.

Copeland was born at Stoke-on-Trent, in Staffordshire, England. His father was a partner of Josiah Spode.

See also **Porcelain**.

Copenhagen (pop. 472,729; met. area pop. 1,358,540) is the capital and largest city of Denmark. Its name in Danish is *København*. The city is Denmark's major port and chief economic, political, and cultural centre. About a fourth of the Danish people live in the Copenhagen area. Some parts of Copenhagen lie on the east coast of the island of Sjælland. Other sections are on Amager, an island just east of Sjælland. For location, see **Denmark** (map).

The city. Town Hall Square lies in the heart of Copenhagen. The city's main streets and highways extend outward from the square, and a number of bus and train routes run through the area. Many office buildings and hotels are near the square, as is the Tivoli Gardens amusement park. Tivoli offers various forms of entertainment, including rides, ballet, and concerts.



Copenhagen is the capital and largest city of Denmark. The city is the nation's major port and serves as the centre of Denmark's economic, political, and cultural activity.

An avenue called Strøget extends between Town Hall Square and the King's New Market, another major square. Strøget, which is closed to motor traffic, has department stores, small shops, and pavement cafes. East of Town Hall Square is Christiansborg Castle, which houses Parliament and the Supreme Court. The National Archives and Royal Library are both situated near the castle.

A world-famous statue called *The Little Mermaid* is in Copenhagen's harbour. It represents a character from a fairy tale by the famous Danish author Hans Christian Andersen. Other attractions in the city include the Amalienborg Palace, the Stock Exchange, and the New Carlsberg and Thorvaldsen museums. Copenhagen is the home of the Royal Danish Ballet and the University of Copenhagen, Denmark's oldest university. The university was founded in 1479.

Economy. Copenhagen is the commercial and industrial centre of Denmark. The city's products include beer, diesel engines, furniture, and porcelain. Trade is also important to the economy of Copenhagen.

Buses and commuter trains provide most public transportation in Copenhagen. Many people ride bicycles, and most of the major streets have special bicycle paths. An international airport lies to the southeast of the city.

History. In the mid-1000's, Copenhagen was a small fishing village. It became a trading centre because of its harbour and, by the 1100's, had developed into a town. It was chartered in 1254 and grew increasingly important economically during the next few centuries. Copenhagen became the capital of Denmark in 1443.

During various periods from about 1250 to 1810, fires and wars destroyed much of Copenhagen, and epidemics killed many of the city's people. Copenhagen recovered each time, however, and continued to grow as an economic, military, and political centre.

Copenhagen expanded to the north and west in the 1850's. During the late 1800's, the city experienced rapid economic growth and began to industrialize. A free port was established in the city in 1894. German troops occupied Copenhagen from 1940 to 1945, during World War II, but the city suffered little damage.

See also **Denmark** (pictures).

Copepod is a small crustacean of the class Crustacea. Copepods may live in fresh or sea water. They are part of the *plankton*, or mass of small organisms that drift near the surface of water. They serve as an important part of the diet of many fish, especially herring. See also **Crustacean**; **Plankton**; **Animal** (picture: Animals of the oceans).

Copernicus, Nicolaus (1473-1543), was a Polish astronomer who developed the theory that the earth is a moving planet. He is considered the founder of modern astronomy.

In Copernicus' time, most astronomers accepted the theory the Greek astronomer Ptolemy had formulated nearly 1,400 years earlier. Ptolemy had said that the earth was at the centre of the universe and was motionless. He had also stated that all the observed motions of the heavenly bodies were real and that those bodies moved around the earth.

Some astronomers before Ptolemy had suggested that the earth did in fact move. The Greek astronomer

Aristarchus had even suggested that the earth and all the other planets moved around the sun. By Ptolemy's time, however, these theories had been rejected. Copernicus knew about some of these early theories. He also believed that Ptolemy's theory was too complicated. He decided that the simplest and most systematic explanation of heavenly motion required that every planet, including the earth, revolve around the sun. The earth also had to spin around its axis once every day. The earth's motion affects what people see in the heavens, so real motions must be separated from apparent ones.

Copernicus skilfully applied this idea in his masterpiece, *On the Revolutions of the Heavenly Spheres* (1543). In this book, he demonstrated how the earth's motion could be used to explain the movements of other heavenly bodies. Copernicus could not prove his theory, but his explanation of heavenly motion was mathematically strong and was less complicated than Ptolemy's theory. By the early 1600's, such astronomers as Galileo in Italy and Johannes Kepler in Germany began to develop the physics that would prove Copernicus' theory correct.

Copernicus was born in Thorn (now Toruń, Poland). He attended the University of Kraków. Through the influence of his uncle, he was appointed a *canon* (church official) in Frauenburg (now Frombork). He studied law and medicine at the universities of Bologna, Padua, and Ferrara in Italy from 1496 to 1506. When he returned to Poland in 1506, he acted as medical adviser to his uncle and served as canon.

See also **Astronomy** (The beginnings of modern astronomy; picture); **Galileo**; **Kepler**; **Johannes**; **Planet** (Explaining the motion of the planets); **Ptolemy**.
Copland, Aaron (1900-1990), was an American composer who wrote in many styles and forms. He won the

1945 Pulitzer Prize for music for the ballet *Appalachian Spring* (1944). In 1949, he received an Academy Award for his music for the film *The Heiress* (1948).

Several of Copland's early works show the influence of French and middle European music of the early 1900's. He also emphasized jazz in such early works as *Music for the Theatre* (1925), for small orchestras, and his *Piano Concerto* (1926). From the mid-1930's to the mid-1940's, Copland incorporated folk music into his compositions. *El Salón Mexico* (1937), an orchestral work, uses traditional Mexican themes. His music for the ballets *Billy the Kid* (1938) and *Rodeo* (1942) includes folk songs of the American West. He blended elements of his earlier styles in *Symphony No. 3* (1946). Beginning in the early 1950's, he revived the "atonal" style of some of his earlier works. His work during this period includes *Piano Fantasy* (1957).

Copland was born in Brooklyn, New York City. His parents were Russian Jews, and he used Jewish themes in such compositions as *Vitebsk* (1929) for cello, piano, and violin. Copland has written several books in an effort to promote wider acceptance of modern music. These books include *What to Listen for in Music* (rev. ed. 1957) and *The New Music, 1900-1960* (rev. ed. 1968). Copland also wrote two volumes of autobiography, *Copland 1900 Through 1942* (1984) and *Copland Since 1943* (1990).

Copley, John Singleton (1738-1815), is generally considered the greatest portrait painter in colonial America. His many superb portraits capture the character of Americans in settings of everyday life. He painted with remarkable directness and vitality, making rich use of colour, texture, and light and shade.

Copley was born in Boston, Massachusetts, U.S.A. In 1766, he sent *Boy with a Squirrel* to a London exhibition.



National Gallery of Art, Washington, D.C., U.S.A.

Copley's family portrait was painted in 1776. The picture shows Copley, his wife and their four children, and the artist's father-in-law. Copley's careful composition and his delicate handling of colour make this one of his finest paintings

The painters Sir Joshua Reynolds and Benjamin West praised this charming portrait and recommended that Copley study in Europe. Copley was having great success in America, so he put off going to London until 1774. He settled there permanently, and his portraits soon took on the brilliant looser brushwork and atmospheric quality characteristic of British painting.

In 1778, Copley began a career as a painter of historical subjects, fulfilling a lifelong ambition. He painted many historical works, the most successful being *Watson and the Shark* (1778) and *The Death of Lord Chatham* (1781). After 1790, Copley's work gradually declined. In the past, critics praised Copley's straightforward, vivid American portraits, and were critical of the lavish portraits and large historical paintings he did in England. Today critics still praise his American works, but view his English works more favourably than in the past.

Coppard, A. E. (1878-1957), a British poet and short-story writer, was noted for the vivid narrative style of his stories. Among the collections of these stories are *Clorinda Walks in Heaven* (1921), *The Black Dog* (1923), *Ninepenny Flute* (1937), *Ugly Anna* (1944), and *The Dark-Eyed Lady* (1947). He wrote *Pink Furniture* (1930) for children. His volumes of poetry included *Hips and Haws* (1922) and *Pelegea* (1926). Alfred Edgar Coppard was born at Folkestone, in Kent, England.

Copper has been one of the most useful metals for over 7,000 years. Today, the uses of this reddish-orange metal range from house gutters to electronic guidance systems for space rockets.

Copper is the best low-cost conductor of electricity. As a result, the electrical industry uses about 60 per cent of the copper produced, chiefly in the form of wire. Copper wire carries most of the electric current inside homes, factories, and offices. Large amounts of copper wire are used in telephone systems, as well as in television sets, motors, and generators.

Combined with other metals, copper forms such alloys as brass and bronze (see **Brass**; **Bronze**). Copper and its alloys can be made into thousands of useful and ornamental articles. In the home, copper serves as a basic material for locks, pipes, plumbing fixtures, door-knobs, and drawer handles. Other commonly used copper products include lamps, pots, pans, roofing, and jewellery.

Chemical compounds of copper help improve soil and destroy harmful insects. Copper compounds in paint serve as pigments and help protect materials against corrosion. Also, copper in small amounts is vital to all plant and animal life.

In ancient times, one of the chief sources of copper for the peoples near the Mediterranean Sea was the island of Cyprus. As a result, the metal became known as *Cyprian metal*. Both the word *copper* and the chemical symbol for the element, *Cu*, come from *cuprum*, the Roman name for Cyprian metal.

Properties of copper

The physical properties of copper make the metal valuable to industry. These properties include (1) conductivity, (2) malleability, (3) ductility, and (4) resistance to corrosion.

Conductivity. Copper is perhaps best known for its ability to conduct electric current. Silver is the only bet-



Copper is mined in every continent of the world. Australia has large deposits, as in the open-cast mine in Queensland, above.

ter conductor, but silver is too expensive for common use. Copper alloys do not conduct current nearly as well as pure copper.

Impurities in refined copper greatly reduce electrical conductivity. For example, as little as $\frac{1}{100}$ per cent arsenic cuts the conductivity of copper by 15 per cent. Copper is also an excellent conductor of heat. This makes it useful in cooking utensils, radiators, and refrigerators.

Malleability. Pure copper is highly *malleable* (easy to shape). It does not crack when hammered, stamped, forged, or spun into unusual shapes. Copper can be *worked* (shaped) either hot or cold. It can be rolled into sheets less than 0.05 millimetre thick. Cold rolling changes the physical properties of copper and increases its strength.

Ductility. Copper possesses great *ductility*, the ability to be drawn into thin wires without breaking. For example, copper rod that is 1 centimetre in diameter can be heated, rolled, and drawn into a wire that is thinner than a human hair.

Resistance to corrosion. Copper is quite resistant to corrosion. It will not rust. In damp air, it turns from reddish-orange to reddish-brown. After long exposure, copper becomes coated with a green film called *patina*, which protects it against further corrosion.

Other properties. Cold-rolled copper has a *tensile strength* from 3,500 to 4,900 kilograms per square centimetre. A material's tensile strength is the maximum stress it can withstand before breaking. Copper keeps its strength and toughness up to about 204 °C.

Properties of pure copper

<div style="font-size: 48px; text-align: center;">Cu</div> <div style="text-align: center; font-size: 10px;">Chemical symbol</div>	Atomic number	29
	Atomic weight	63.546
	Density (at 20 °C)	8.96 (g/cm ³)
	Melting point	1083.4 °C
	Boiling point	2567 °C

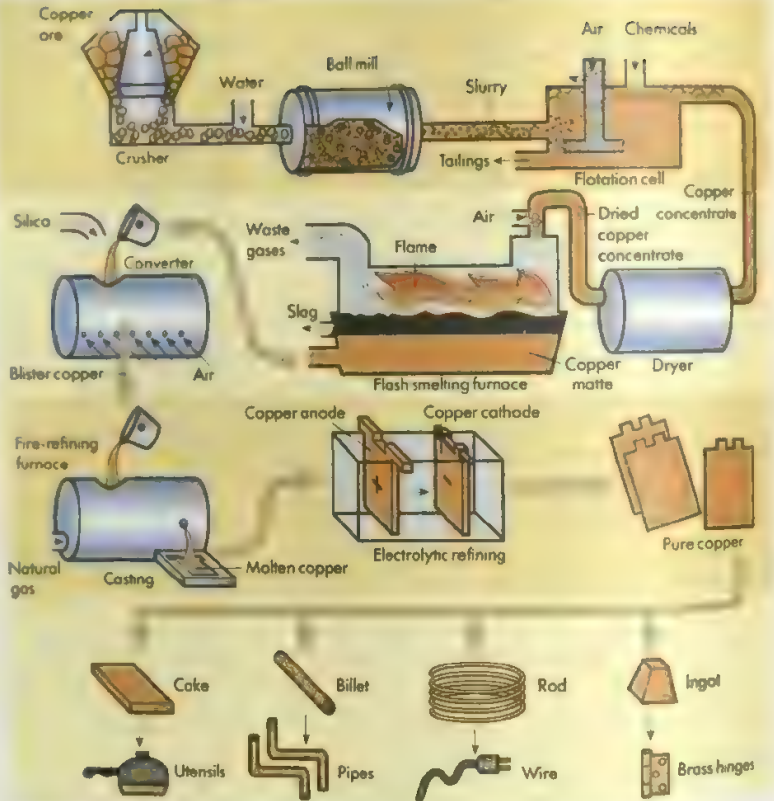
How copper metal is produced

Milling begins when a crusher reduces copper ore to small pieces. Water is added to form a mixture called *slurry*. A ball mill grinds the crushed ore in the slurry into fine particles. The particles become concentrated in a flotation cell

Smelting removes many impurities from the copper concentrate. A flash furnace eliminates impurities in the form of gases and *slag* (solid waste), producing copper matte. A converter further purifies the molten copper.

Electrolytic refining uses slabs cast from the molten copper supplied by the converter. During this refining process, an electric current produces chemical reactions, which yield copper metal that is over 99.9 per cent pure.

Final processing consists of melting and casting the copper metal into cakes, billets, rods, and ingots. Such forms are used to manufacture various copper products, including kitchen utensils, pipes, wires, and brass hinges.



WORLD BOOK diagram by Garri Budyshy, Artios

Copper ores

Seven kinds of ores provide most of the world's copper. These ores may also contain other metals, such as lead, zinc, gold, cobalt, platinum, and nickel. Copper ores usually contain less than 4 per cent copper. Some ores may yield as little as 0.2 per cent of copper.

The chief copper ores are *sulphides* (sulphur compounds). They include bornite, chalcocite, and chalcophyllite. *Oxidized ores*, such as azurite, cuprite, and malachite, also yield valuable amounts of copper. Almost pure copper, called *native copper*, rarely occurs in nature. Native copper supplies only a small percentage of the world's total copper production.

Sources of copper

About 8.3 million metric tons of copper are mined each year throughout the world. Every continent has copper deposits. Much of the world's copper comes from the mountain ranges extending from Alaska in the United States to the tip of South America.

In some places, miners dig copper ore from mines far below the earth's surface. Elsewhere, they remove it from huge open pits at the surface. In *open-cast* mining, large power shovels or other machines remove the ore from wide "steps" 12 to 21 metres high. See Mining (picture: In an open-cast copper mine).

Chile is the world's leading copper-producing nation.

Large mines near Santiago and in the Atacama Desert provide most of Chile's copper.

The United States mines about a fifth of the world's copper. But it uses more copper than it mines, and it imports copper. About two-thirds of the copper mined in the United States comes from Arizona. Canada mines about a tenth of the world's copper. Most of it comes from British Columbia and Ontario.

Peru, Poland, and Zambia are also important copper producers. Large copper deposits also occur in Australia, China, Mexico, and Zaire.

Recycling. Copper is readily recycled from scrap wire, motors, car radiators, and electronic equipment. Recycled scrap can supply a substantial amount of a country's copper requirement.

Obtaining copper from the ore

At the mine, large power shovels load the copper ore, frequently in the form of big boulders, into trucks or railway wagons. These vehicles carry the ore to mills. Not all ores go through exactly the same processes. However, all the processes are designed to separate valuable minerals from the ore and waste rock, to extract copper and other metals that may be in the resulting mixture, and to purify these metals.

In a typical process, the ore is sent to the mill, where it is crushed and the waste rock removed. The resulting material is then sent to the smelter, where the metallic

Leading copper-mining countries

Tons of copper produced in a year



Figures are for 1991, prior to the breakup of the Soviet Union.
Source: U.S. Bureau of Mines.

copper is separated from impurities. This copper may contain other metals, such as gold, silver, and nickel, that must be removed by refining.

Milling starts in a *crusher*, where the ore is broken into small pieces. Then water is added to the crushed ore to form a souplike mixture called *slurry*. The slurry passes into *ball mills*, which are rotating, drum-shaped cylinders partially filled with iron balls. As the cylinders rotate, the balls grind the ore into particles small enough to pass through a screen with 1,600 openings per square centimetre.

The slurry next goes through a *flotation process* that concentrates the mineral-bearing particles. The slurry first passes into tanks called *flotation cells*. There, chemicals and oil are added, and the entire mixture is agitated with air to make it bubble. One chemical makes the bubbles stable. Another coats the mineral particles so that they stick to the bubbles. The bubbles rise to the top of the cell with the particles and form a froth. This froth is skimmed off and dried. The product, called *copper concentrate*, may contain from 15 to 33 per cent copper. The waste material, called *tailings*, does not become attached to the bubbles. It is emptied from the lower part of the flotation cell and sent to storage ponds.

Smelting removes most of the remaining impurities from the copper. In smelting, copper concentrate is dried, then blown with air and pure oxygen into a *flash smelting furnace*. Such a furnace can smelt as much as 2,700 metric tons of copper concentrate per day. In the furnace, the concentrate burns and melts, releasing some impurities in the form of sulphur dioxide gas. The *molten* (melted) material falls to the bottom of the furnace, where it separates into *slag* and *copper matte*. Slag, which contains iron oxide, silica, and other impurities, rises to the surface. The slag is discarded. Copper matte is heavier and collects under the slag. Copper matte contains from 50 to 75 per cent copper. It also contains some impurities in the form of iron sulphide and other metals.

In the next stage of the process, the molten matte goes through a *converter*. In the converter, blowers force air through it, and silica is added. The silica combines with the impurities, forming slag. The slag is again skimmed from the top. The new mixture is called *blister copper* because the surface blisters as the copper cools. Blister copper is from 97 to 99.5 per cent pure.

The blister copper is refined in a *fire-refining furnace*.

This furnace removes most of the remaining impurities mainly oxygen. In a process called *poling* or *reduction*, natural gas is blown into the *melt* (furnace load) of molten copper. As the natural gas burns, oxygen and other gases are removed from the copper. The resulting copper is 99.9 per cent pure.

Electrolytic refining. Copper to be used in electrical conductors must be electrolytically refined to a purity of more than 99.9 per cent. To do this, *fire-refined copper* is cast into cakes about 91 centimetres square and 5 centimetres thick. The cakes serve as *anodes* (positive poles) in the electrolytic process. For a discussion of this process, see *Electrolysis*.

The copper anodes are put into tanks containing a solution of copper sulphate and sulphuric acid. They are suspended alternately with *cathodes* (negative poles), which are thin sheets of pure copper called *starter sheets*. When an electric current passes through the tank, the anode bars gradually dissolve, depositing copper more than 99.99 per cent pure on the cathodes. Most of the remaining impurities in the anodes settle to the bottom of the tank and form a *sludge*. Processors use various methods to recover gold, silver, platinum, and other metals from the sludge. After electrolysis, the copper cathodes are usually melted in a furnace and cast into various shapes and sizes, such as rods, cakes, ingots, and billets.

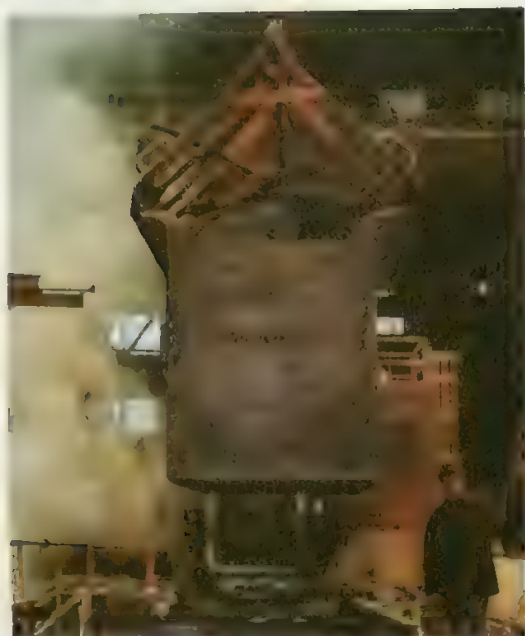
Leaching is a method of dissolving metal out of ore with a chemical solvent. Leaching recovers copper from ores that do not react to the chemicals used in the flotation process. In leaching, water containing sulphuric acid or other chemicals circulates through the ore and dissolves the copper. The solution is then mixed with a kerosene solvent containing chemicals that extract the copper. The mixture separates and the copper-bearing chemicals flow into a sulphuric acid solution. This solution is put into a tank to undergo *extraction-electrowinning*, a process similar to electrolytic refining. The resulting copper is about 99.9 per cent pure.

Making copper products

Fabricating plants, such as brass and wire mills, make semifinished forms including sheets, tubes, and wires. They make these forms from copper rods, cakes, ingots, and billets. Manufacturers of copper products buy the semifinished forms from these plants.

Copper sheets are rolled from copper cakes that measure about 64 centimetres wide, 20 centimetres thick, and up to 183 centimetres long. The cakes are heated in a furnace to about 926 °C, then rolled on a hot mill into sheets about 13 millimetres thick. Other mills finish the sheets by rolling them to exact thicknesses. The sheets are then cut into pieces of the required size to make such products as roofing sheets and cooking utensils.

Copper tubes are made from copper billets that vary in diameter from 8 to 23 centimetres and are up to 132 centimetres long. Workers heat the billets in a furnace, then pierce them to produce a rough pipe. The pipe shells thus formed are forced through round holes in *dies* (metal plates) and over other devices to produce tubes of the required size. The tubes are used to make plumbing pipes, household gas lines, and electrical conduits.



A **copper anode** is a large, rectangular cake of blister copper used in the electrolytic refining process to produce copper that is more than 99.9 per cent pure.

Copper wire is produced by melting copper cathodes and casting the molten copper into a bar about 10 centimetres wide and 7.5 centimetres thick. The bar is rolled into a rod about 0.8 centimetre in diameter and then coiled into large rolls. The rod is then pulled through a wire-drawing machine. This machine reduces the rod to the desired wire size. Most copper wire is used to carry electric current.

Extruded copper. Some copper is *extruded* (squeezed) through a hole in a die to form the desired shape. Copper can be extruded into rods, tubes, and other special shapes. These are made into hinges, drawer handles, and other pieces of hardware.

History

Copper was one of the first metals known to human beings. It came into use because early peoples found it in native condition and could easily beat it into small tools, weapons, and ornaments.

Early civilizations. Copper was probably first used about 8000 B.C. by people living along the Tigris and Euphrates rivers in the Middle East. As early as about 5000 B.C., people throughout the Middle East knew how to heat and hammer copper into sheets to make larger tools, weapons, and ornaments. Copper was later used by many peoples, including the Chinese and the American Indians.

About 3500 B.C., people discovered how to melt copper with arsenic to make bronze. At about the same time, they learned to smelt copper from ore. From about 3000 B.C. to about 1100 B.C., bronze made with tin instead of arsenic became important (see **Bronze Age**). The process of combining zinc with copper to make brass was probably discovered sometime after 1000 B.C.

The Romans started making brass coins in the 100's B.C.

Industrial developments. From early times until the A.D. 1800's, ample high-grade ore was available, and methods for processing and using copper changed only slightly. By the late 1800's, the rapid growth of electric lighting and telephone and telegraph systems had greatly increased the demand for copper, which dwindling deposits of high-grade ore could not meet. Also, most native copper deposits had been used up.

Geologists had located large ore deposits in the United States and Chile. But the copper content of the ore was so low that the ore could not be processed at a profit.

About 1900, a young American mining engineer in Utah, Daniel C. Jackling, realized that low-grade ores could be processed cheaply by using mass-production methods. His process involved the use of steam shovels to strip off surface rock. Other special mass-production equipment was used for smelting and refining. New techniques for separating copper from the ore also increased the supply of available copper.

Related articles in *World Book* include:

Copper products

Brass	Monel metal	Wire
Bronze	Nickel silver	

Other related articles

Alloy	Chalcocite	Malachite
Azurite	Chile (picture)	Mineral (picture)
Chalcocite		

Copperhead is the name of two different poisonous snakes, one North American, the other Australian. The American snake is one of the pit vipers. Its body has broad chestnut-red bands. Most copperheads are about 75 centimetres long. The largest grow to about 1.2 metres.

The American copperhead bites people more often than most rattlesnakes, partly because it is silent and smaller, and is not so quickly noticed. The bite is seldom fatal to adults, but can seriously poison children who weigh less than 35 kilograms. This reptile usually eats rodents and other mammals. The prey are first killed with the poison, and then swallowed whole. Sometimes the copperhead eats insects and frogs. It gives birth to from three to seven young in August or September. The copperhead lives in the eastern, southern, and midwestern United States.

The Australian copperhead lives in the highlands and



The American copperhead can be recognized by the broad chestnut-coloured bands along its body.



The Australian copperhead snake

colder parts of Tasmania and southeastern Australia. Most are rich brown to reddish or black above, and cream to pink below. They are not aggressive but their venom is extremely potent. The snakes are active at night, even during cold weather. They eat frogs, and other reptiles.

Scientific classification. The American copperhead belongs to the viper family, Viperidae. It is *Agkistrodon contortrix*. The Australian copperhead belongs to the coral snake family, Elapidae. It is *Austrelaps superbus*.

See also Snake; Viper.

Coppola, Francis Ford (1939-), is an American film director, producer, and writer. His most important films include *The Godfather* (1972), *The Godfather, Part II* (1974), and *The Godfather, Part III* (1990), which cover almost 100 years in the life of an American family involved in organized crime. His *Apocalypse Now* (1979) was the first major American film to deal with the Vietnam War. Coppola won Academy Awards for co-writing the screenplays for *Patton* (1970) and the first two *Godfather* films, and for directing *The Godfather, Part II*.

Coppola was born in Detroit. He received a Master of Cinema degree in 1968. He submitted his first important film *You're a Big Boy Now* (1966), as his master's thesis. Coppola's other films include *The Conversation* (1974), *The Outsiders* (1983), *Peggy Sue Got Married* (1986), and *Dracula* (1993).

Copra is the dried meat of the coconut. Copra is valuable for its oil, which is used in the manufacture of soap, candles, margarine, detergents, cosmetics, and other products. Copra is one of the main exports of islands in the Pacific Ocean.

Coconut meat is dried in the sun or in ovens called kilns, or by using hot air. Drying removes water from the meat, allowing the meat to keep for a longer period of time.

The oil in copra is pressed out. The remaining cake, called coconut steamin or poonau, is used for fodder and poultry feed. Copra yields from 50 to 65 per cent of its weight in oil. Thirty average coconuts produce about 3.8 litres of oil. See also Coconut palm; Pacific Islands (picture: Producing copra)

Copts is a term first used to refer to certain native residents of ancient Egypt. The Copts spoke a version of the ancient Egyptian language enriched by many Greek words and written with a modified Greek alphabet. The name Copts also refers to members of the Coptic Orthodox Church in modern Egypt, who use the Coptic language in their church service. However, like other Egyptians today, Copts speak Arabic.

The Copts played a leading role in the development of the early Christian church. In the late A.D. 200's, a Copt, Anthony of Thebes, founded the early Christian monastic movement. The Copts were greatly interested in the lives and sayings of the saints. Most surviving Coptic literature concerns this subject. The Copts also emphasized the unity of the human and divine in Christ's nature, a belief known as the *Monophysite doctrine*. At the Council of Chalcedon in 451, however, the church leaders from Rome and Constantinople declared that Christ had two separate natures and condemned the powerful Coptic *patriarchate* (ruling division) in Alexandria, Egypt. Although some Copts submitted to the Council's decisions, most chose to establish an independent church with its own patriarch and clergy.

In 642, Muslim Arabs conquered Egypt, and many Copts converted to Islam. Today, only a few million Copts live in Egypt, while other small Coptic communities are scattered throughout the world. In the 1970's, Coptic church leaders met with various Eastern Orthodox Churches and the Roman Catholic Church to explore the possibility of reunion.

In the 1990's, Copts were affected by the conflict between Egypt's government and militant Islamic groups. Muslim radicals killed about 20 Copts and set fire to several Coptic churches in 1992 and 1993. This was part of a general campaign against Christian influence in Egypt.

Copyright refers to a body of exclusive rights that protect the works of authors and other creative people against copying or unauthorized public performance. Copyright generally extends to original works of literary, dramatic, musical, or artistic expression. The first modern copyright law was adopted in Great Britain in 1709. Today, most nations have copyright laws that cover original works produced at home or abroad.

Patents and trademarks are distinct from copyrights. A patent mainly prevents inventions and discoveries or improvements of useful processes from being copied. A trademark is a word, name, or symbol that is designed to distinguish the products or services of one company from those of another.

Works protected. Copyright law covers numerous types of original work. Such work may be literary, musical, dramatic, *choreographic* (dance), pictorial, graphic, or sculptural. Other categories include films and other audio-visual works, sound recordings, and computer programs. Literary works include novels, poems, and other works such as computer programs, catalogues, directories, and collections of data. Musical works include original compositions and arrangements, and any words that accompany the music. New versions of earlier compositions may also be copyrighted.

Dramatic works mainly include plays intended for live performance, and screenplays. The copyright covers music accompanying various dramatic productions, such as operas, musical comedies, and TV plays.

Choreographic works and mime can be copyrighted if they are represented on film or tape, or if they are written down. Choreographic works do not include social dance steps.

Pictorial, graphic, and sculptural works include photographs, holograms, greeting cards, picture postcards, cartoons, comic strips, posters, ceramic figurines, glassware, and decals. Lithographs, etchings, and other art reproductions by the original author are also covered, as are maps, charts, and architectural and technical drawings, various designs and patterns, and other examples of visual arts.

Motion pictures include all works consisting of a sequence of visual images, regardless of whether the images are displayed on film, tape, or disc. The copyright extends to filmstrips and other works that consist of sequences of images but do not give the impression of motion when shown. Sounds accompanying motion pictures and audio-visual works are also protected. Other audio-visual works include certain television and radio broadcasts.

Sound recording means a record of sounds, such as a disc, tape, or other form from which the sounds are capable of being reproduced automatically, other than the soundtrack of a film.

Copyright protection applies only to the extent of a person's expression. No protection is available for ideas, concepts, names, titles, short phrases, general themes, or familiar symbols.

Owners' rights. A copyright carries with it the exclusive right to reproduce and distribute copies or records of the copyrighted work. However, once a copy has been sold, the purchaser may resell or rent the copy without permission of the copyright owner.

A copyright also gives the owner the sole right to prepare works based upon the copyrighted work, such as translations, condensations, and motion-picture versions. In addition, the owner has the exclusive right to perform the work publicly if it is a literary, musical, dramatic, or choreographic work; or a motion picture or other audio-visual creation. The copyright owner has the sole right to display the work publicly if it is a pictorial, graphic, sculptural, literary, musical, dramatic, or choreographic work; or individual images from a motion picture or other audio-visual work.

Owners of copyrighted material may transfer their rights to someone else by an assignment in writing or by will on their death. If no provision is made by will, the copyright passes to a person's heirs automatically with his or her other personal property. Copyright holders may also grant licenses to other people, giving them permission to reproduce their work for a stated period of time.

Where two or more people have joint ownership in a copyright by virtue of being joint authors, the copyright is shared. Neither owner has an exclusive right to reproduce the work. Normally, where a person produces literary or artistic work during the course of employment by another person, the employer owns the copyright in the work.

The rights of a copyright holder can only be invoked if someone else tries to infringe them. Therefore, it has been said that copyright is a negative right. The usual remedy sought is a court injunction to prevent the in-

fringement of the right. Compensation may also be paid to the copyright holder in the form of damages. Any tangible work produced as a result of the infringement may be destroyed. Criminal proceedings may also be taken against people who make, sell, or hire copies of works which infringe copyrights.

Users' rights. Not every use of copyrighted material is an infringement of the copyright. *Fair dealing*—the limited reproduction of copyrighted material for the purposes of study or research—is permissible, as is criticism, review, and news reporting as long as an acknowledgement of the title of the work and its author is given. Neither is there infringement of copyright if the work is reproduced for the purpose of judicial proceedings. There are further exceptions to the rules of infringement in respect of schools, libraries, and archives, and for other educational purposes.

International conventions. The first international convention relating to copyright was the Berne Convention for the Protection of Literary and Artistic Works of 1886. The 14 countries that adopted it agreed certain standard rules for the protection of literary and artistic works and also agreed to protect works published in each of the member countries.

The Berne Convention was revised several times and many more countries joined over the succeeding years. Member countries now agree to grant copyright protection for 50 years from the date of publication of literary or artistic work, or 50 years from the death of the author of unpublished work. No registration or special requirements are necessary to secure this right. But, under the convention, copyright protection for a work in its country of origin is governed by that country's own domestic law, which may require certain formalities, such as registration. The member countries include Australia, India, Japan, and New Zealand; most European countries; and many African, Latin American, and Asian countries. The United States became a member in 1989, but some provisions of earlier copyright law still apply. China and the Soviet Union are not members, and there are still many other countries that offer little or no copyright protection to any foreign works.

At the Paris Convention in 1971, it was agreed to uphold the previously established provisions of the Berne Convention, but it was also agreed to allow developing countries more latitude in using copyrighted material for educational purposes.

Until 1989, United States copyright law differed from copyright law in the countries of the Berne Union. In order to provide some mutual protection for copyright holders in the United States and the Berne Union countries, a meeting was held in 1952, in Geneva, and the Universal Copyright Convention was agreed upon. Countries which ratified the agreement included many Berne Union countries, the Soviet Union, the United States, and several other Latin American countries which had previously held agreements with the United States. The Convention is administered by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in Paris. Although it gives copyright protection for work published in one country in all other member countries, it does not have the broad scope and detail of the Berne Convention. The term of protection is not less than 25 years in any country. The symbol ©, to-

gether with the name of the author and the date of publication, is recognized by each member country as an indication that any requirements necessary for copyright have been carried out in the country from which the work comes.

Sound recordings are the subject of the 1971 Geneva Convention for the Protection of Producers of Phonograms against Unauthorized Duplication of their Phonograms. There are over 40 member countries, including the United Kingdom and the United States. For sound recordings, the symbol © is used with the year of first publication in the same way as the symbol © is used for literary works.

History. The first modern copyright law was the Statute of Anne, passed by the British Parliament in 1709. This law made copyrights available to anyone for 14 years. Britain's Universities Copyright Act of 1775 helped explain the conditions under which an infringement suit could be brought.

See also Patent; Plagiarism; Trademark.
Copywriter. See Advertising (Creative work).

Coral is a limestone formation formed in the sea by millions of tiny animals. Coral formations may look like branching trees, large domes, small irregular crusts, or even like tiny organ pipes. The living coral-forming animals colour the formation in beautiful shades of tan, orange, yellow, purple, and green. When the animals die, they leave limestone "skeletons" that form the foundations of barriers and ridges in the sea called *coral reefs*.

Many colourful sea animals live among the corals. These animals include fishes, starfish, and sea anemones.

Sometimes coral masses build up until they rise above the water to form *coral islands*. The grinding, battering sea helps to build coral islands. It breaks up the coral growths and piles them up. Other creatures, such as calcifying algae, cement the pieces together and a rigid structure is formed. Often, soil lodges on the coral and vegetation begins to grow. Many islands in the Pacific Ocean were formed this way. *Precious corals* live in colder waters. Certain corals grow as far north as the Arctic Circle.

Destruction of coral reefs. Coral reefs are unique because they are so rich in animal life and because they take many hundreds of years to develop. In many places round the world, however, the reefs are being destroyed. The destruction occurs in a number of ways: the reefs are mined for building materials; they become buried in silt that runs off eroded hillsides; and they are polluted by sewage that is pumped out to sea. In addition, fishermen blow up coral reefs to catch fish, which they sell either for food or as aquarium fish. Coral reefs are also broken up so that pieces can be sold to tourists as souvenirs.

Coral reefs are found mostly in warm, shallow, and tropical seas, because the reef-forming corals cannot live in water colder than 18° C. Reefs abound throughout the South Pacific, in the East Indies and the Indian Ocean to Sri Lanka, and around Madagascar on the southeastern African coast. They also form along the tropical eastern coast of Brazil, through the West Indies, along the Florida coast, and at Bermuda. There are three types of coral reefs: (1) fringing reefs; (2) barrier reefs and (3) atolls.



Coral reefs are rich in species of marine life. A single reef like the one shown on the left may contain 3,000 species of marine organisms, including corals, crustaceans, fish, molluscs, and worms. Coral reefs are being destroyed for many reasons, including the spread of pollution. If a reef is destroyed, it may take hundreds or even thousands of years to reestablish itself.

Fringing reefs are submerged platforms of living coral animals. These reefs extend from the shore into the sea.

Barrier reefs follow the shoreline, but are separated from it by water. They form a barrier between the water near the shore and the open sea. A barrier reef may consist of a long series of reefs separated by channels of open water. Such reefs usually surround volcanic islands of the South Pacific. The Great Barrier Reef of Australia, about 2,010 kilometres long, is the largest coral reef in the world.

An **atoll** is a ring-shaped coral island in the open sea. It forms when coral builds up on a submerged mudbank or on the rim of the crater of a sunken volcano. The atoll surrounds a body of water called a **lagoon**. One or more channels connect the lagoon to the open sea. Many coral islands of the South Pacific Ocean are atolls.

How coral is formed. The animals that form coral belong to the same animal group as the hydras, jellyfish, and sea anemones. Most individual coral animals, called **polyps**, are less than 2.5 centimetres in diameter, but a small percentage of them measure as much as 30 centimetres in diameter. A coral polyp has a cylinder-shaped body. At one end is a mouth surrounded by tiny **tentacles**. The other end attaches to hard surfaces on the sea bottom.

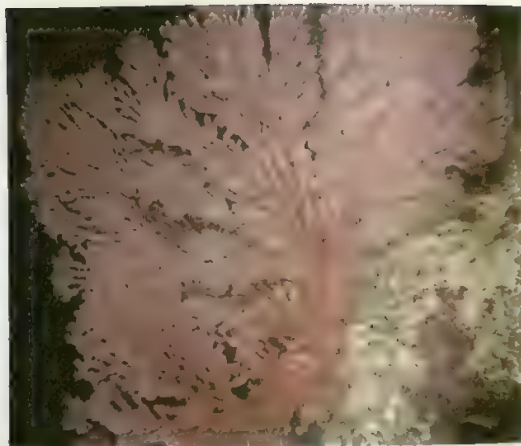
Most coral polyps live together in colonies. The **stony corals** attach themselves to each other with a flat sheet of tissue that connects to the middle of each body. Half of the coral polyp extends above the sheet and half below. Coral polyps build their limestone skeletons by taking calcium out of the seawater. Then they deposit **calcium carbonate** (limestone) around the lower half of the body. As new polyps grow, the limestone formation becomes larger and larger.

Coral polyps feed mainly on tiny swimming animals, such as the **larvae** (young) of many kinds of shellfish. Reef corals cannot live without algae. They use some food manufactured by algae that live in the polyps' own tissues. These algae produce chemicals that help the coral animals secrete their limestone skeletons. Coral reefs grow only in water with enough light for photosynthesis to occur in the algae.

Coral polyps reproduce either from eggs or by **budding**. Small, knoblike growths called **buds** appear on the body of an adult polyp, or on the connecting sheet, from time to time. These buds grow larger, separate from the parent, and then begin to deposit their own limestone in the colony. Budding thus helps the colony increase its size.

New colonies of coral polyps form when the adult polyps of an old colony produce eggs. The eggs grow into tiny forms that swim away. Then the developing animals settle to the sea bottom and begin to form new colonies by budding.

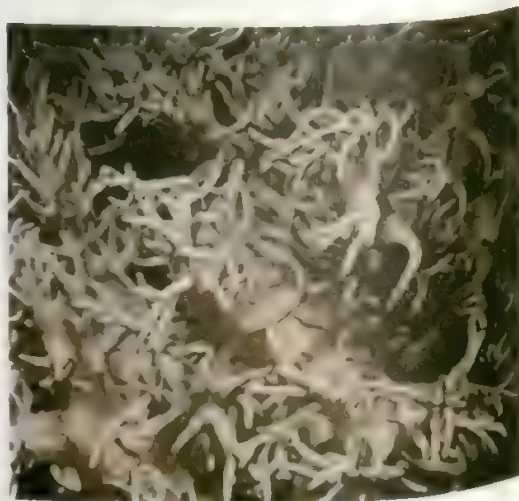
Various marine animals eat living coral-forming animals. The loss of coral to such animals is usually balanced by the development of new coral colonies and the growth of old ones. But beginning in the 1960's, large numbers of crown-of-thorns starfish destroyed stony coral colonies on many reefs of the southwest Pacific Ocean. Scientists are trying to determine what could have caused this species of starfish to become so numerous.



Sea fan corals are known for their bright colours.



Reef-building corals grow in warm seas.



Soft corals look like deer's antlers.



Dwarf corals have brightly coloured polyps.



Mushroom corals are produced by one large polyp.



Lettuca corals have a delicate leaflike appearance.

Precious corals do not live on coral reefs. They live in colder, deeper waters, such as in the Mediterranean Sea and the Sea of Japan. These corals are also made up of colonies of polyps, but the skeletons are internal rather than external. Precious coral is a *species* (kind) valued for jewellery. It has a hard *core* (internal skeleton) that can be polished. Polishing brings out beautiful red, rose, or pink colours.

Scientific classification. Corals are in the phylum Cnidaria, class Anthozoa.

Related articles in *World Book* include:

Atoll	Gem (picture)
Australia (picture)	Gorgonian
Barbados	Great Barrier Reef
Bermuda	Limestone
Cnidarian	Sea fan

Coral Sea is the part of the Pacific Ocean between the northeast coast of Australia, the Solomon Islands, and the Vanuatu island group. It has an unusually large number of coral atolls and barrier reefs, including the Great Barrier Reef. The boundaries of this sea are so indefinite that the name could be applied to large parts of the Southern Pacific. The reefs along the western shores of the Coral Sea have fine specimens of coral (see **Coral**).

United States and Japanese naval forces fought a key World War II battle in the Coral Sea. Neither side won a clear-cut victory, but the Japanese offensive was checked for the first time in the war.

See also **Pacific Islands** (map).

Coral Sea, Battle of the. See **Air force** (table: Famous air battles); **World War II** (The Battle of the Coral Sea).

Coral Sea Islands stretch northeast from the Great Barrier Reef. Many of these scattered reefs and islands are little more than sandbanks. They are spread over a million square kilometres with only a few square kilometres of actual land area. They were declared an Australian territory in 1969. See also **Coral Sea**.

Coral snake is the name given to several closely related poisonous snakes of the Western Hemisphere. They are found in the southern United States, Mexico, Central America, and tropical South America. Coral snakes have small, blunt heads and brightly coloured bodies.

Coral snakes are extremely poisonous. They do not strike as effectively as other venomous snakes, but they bite. They are dangerous if stepped on or handled. They are snake eaters.

The bright colours of the coral snake probably act as a warning to predators, such as birds, that the snake is poisonous. During the day, when the coral snake is resting, any predator that uncovers the snake is startled by its bright colours, set against a background of leaves or earth. The snake's body pattern also probably serves as *camouflage*, helping to break up the outline of its body when it is active at night and during twilight hours.

The *eastern* coral snake generally ranges from 50 to 100 centimetres in length. It lives in the southeastern United States and in extreme northeastern Mexico. Its body is encircled by broad black and red bands separated by narrow yellow ones. Just behind the snake's black snout is a wide yellow band followed by a black band. Some nonpoisonous snakes look like coral snakes because they have similar colouring. But coral snakes



A coral snake from Central America shows the typical black, yellow, and red pattern of many species of coral snakes.

generally have red and yellow bands next to each other. The harmless snakes have red and black bands together.

The western, or Arizona, coral snake is about 45 centimetres long. It lives in the southwestern United States and in northern Mexico. It also has a black snout. Behind the snout is a white or yellow band followed by a red band.

The South American coral snake is about 1.2 metres long. It is common in tropical South America. Its body is encircled by bands of bright red separated by broad bands of black. Within each black band are two narrow bands of white or yellow. The white or yellow bands do not touch the red bands, a characteristic that distinguishes this snake from North American coral snakes. The scales of the snake are shiny and polished.

Scientific classification. Coral snakes belong to the family Elapidae. The eastern coral snake is *Micrurus fulvius*; the western, or Arizona, coral snake is *Micruroides euryxanthus*; and the South American coral snake is *Micrurus lemniscatus*.

Coral tree, also known as *coralbean*, is the name of more than 100 species of trees and shrubs that grow in tropical and nearly tropical regions throughout the world. Most coral trees are *deciduous*—that is, they lose their leaves and grow new ones each year.

Coral trees have compound leaves made up of three leaflets. Many species have thorns along the branches and even on the *petioles* (stems) of the leaves. Most coral trees bear large, showy flowers that are red or orange. Birds pollinate the flowers.

The red and black seeds of many species of coral trees are used for necklaces and other jewellery. However, the seeds commonly contain substances that are poisonous if eaten. Local peoples extract some of these substances for use in medicines.

Scientific classification. Coral trees make up the genus *Erythrina* in the pea family, Fabaceae or Leguminosae.

Corbusier. See Le Corbusier.

Corby (pop. 52,300) is a local government district in Northamptonshire, England. The district comprises the new town of Corby and seven surrounding villages.

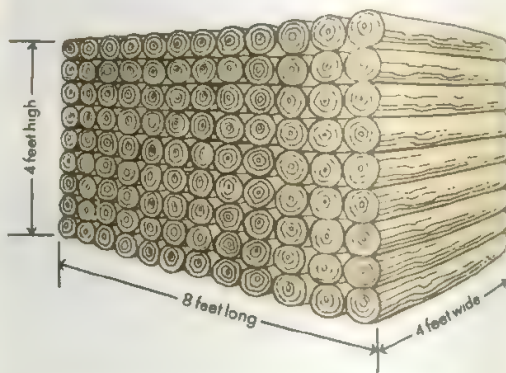
From about 1930 to 1980, the chief industry was steel-making. Steelmaking has ceased, and the only related industry to survive is the manufacture of steel tubes. The district's products now include clothing, electrical and engineering goods, optical products, plastics, proc-

essed foods, and shoes. East Charlton Park is a local countryside park. The district includes the village of Rockingham, frequented by Charles Dickens.

See also Northamptonshire.

Cord is a unit for measuring firewood. A cord has a volume of 128 cubic feet (3.6 cubic metres). Any set of numbers totalling 128 cubic feet would be a cord. For example, a pile of wood 4 feet (1.22 metres) wide, 4 feet high, and 8 feet (2.44 metres) long would represent a cord (4 feet \times 4 feet \times 8 feet = 128 cubic feet). The cord is not generally recognized as a legal measure.

See also Weights and measures.



A cord of wood is 128 cubic feet (3.6 cubic metres).

Corday, Charlotte (1768-1793), a French patriot, killed Jean Paul Marat, a radical leader of the French Revolution, during the Reign of Terror in 1793. She was tried in a Revolutionary court and guillotined. She sympathized with the Girondists, a group of representatives in the French legislature (see Girondists). When the Girondist leaders were arrested, Corday resolved to kill Marat, an opponent in the legislature. She obtained an interview with him. While he was in his bath, she stabbed him to death. Charlotte Corday was born in Normandy, France. See also Marat, Jean Paul.

Cordial. See Alcoholic beverage (Liqueurs).

Cordillera is a group of mountain ranges, usually the principal mountain group of a continent. The word *cordillera* comes from the Spanish word *cuerda*, which means *cord* or *chain*. Spaniards use the word to mean any mountain chain. The term *cordillera* once was used in America to mean only the Andes Mountains. Geographers now use the term to mean any group of mountain systems, such as the western cordillera of North America, which includes the Sierra Madre, the Rockies, the Sierra Nevada, the Cascade Range, the Coast Ranges, and the Great Basin ranges. South America, Asia, and Europe also have cordilleras.

Cordite is one of the original smokeless powders used to propel projectiles from guns. The name *cordite* refers to the cordlike lengths in which it is made. Cordite is 30 per cent nitroglycerin, 65 per cent nitrocellulose, and 5 per cent petrolatum. The British government adopted the original cordite formula in 1887. This cordite burned with so much heat it damaged gun barrels.

Córdoba (pop. 1,179,372) is Argentina's second largest city. Only Buenos Aires, the capital, has more peo-

ple. Córdoba is a major industrial centre and the capital of the Argentine province of Córdoba. The city lies in northern Argentina, at the base of a mountain range called the Sierra de Córdoba. For location, see Argentina (political map).

Córdoba ranks as Argentina's top producer of cars and tractors. It is also a leading manufacturer of textiles and of glass and leather products. Despite its industrialization, Córdoba has preserved many traditional features. These features include old churches, public squares, and promenades. Argentina's oldest university, the National University of Córdoba, is in the city. It was established in 1613.

Córdoba was founded in 1573 by Spaniards who had come to the area from Chile. Its location on early trade routes to Chile and Peru, along with rich agricultural land surrounding the city, helped Córdoba grow and prosper.

Córdoba (pop. 284,737) is an ancient Moorish city in Spain, and the capital of Córdoba province. It lies 138 kilometres northeast of Seville. For location, see Spain (political map).

Romans occupied Córdoba in 206 B.C. It reached its peak of importance in the A.D. 900's as a famous centre of Moorish art and culture. A mosque is Córdoba's chief landmark. It was built as a Muslim house of worship in the 700's, and was made into a Roman Catholic cathedral in 1238. More than 1,000 pillars of granite, onyx, marble, and jasper support its arches.

Nearby farms produce cereals, grapes, olives, and vegetables. Córdoba is the home of soft, fine-grained cordovan leather.

Corduroy is a cotton or cotton blend fabric with raised ribs of the cloth running lengthwise. The name probably comes from the French phrase *cord du roi*, meaning *king's cord*. Corduroy with wide ribs is called *wide-wale corduroy*. The type with narrow ribs is called *pin-wale corduroy*. Corduroy is made 137 centimetres wide for clothing, and upholstery. It may be in one colour or a variety of printed patterns.

Core, in geology. See Earth (Inside the earth).

Corelli, Arcangelo (1653-1713), was one of the earliest major violinists and composers of violin music. Corelli's compositions became models for both solo and ensemble music for the violin. He developed the *concerto grosso*, which combines a large instrumental group with a trio that usually consists of two violins and a cello. Corelli also wrote violin sonatas in four *movements* (sections), which became a standard form for later sonata compositions. Corelli's works have been grouped into six collections. Each of the first five collections consists of 12 sonatas. The sixth is a collection of 12 *concerti grossi*.

Corelli was born in Fusignano, near Imola, in Italy. He studied violin as a teenager at the Accademia Filarmonica in Bologna, but spent most of his adult life in Rome. He gained a reputation as an excellent musician and conductor and was popular in Roman social circles. For many years, he directed an important series of concerts at the palace of his friend and patron, Cardinal Pietro Ottoboni.

Corelli, Marie (1855-1924), won fame as a romantic novelist. Her books include *Romance of Two Worlds* (1886), *Barabbas* (1893), and *The Sorrows of Satan* (1895).

Marie Corelli was born in London. Her real name was Mary Mackay. Although she was a talented musician, she took to writing instead. She lived in at Stratford upon-Avon, Warwickshire, England.

Coreopsis is a large group of plants related to the sunflower. In North America, where they grow wild, they are commonly called *tickseeds*. The plants may be from 45 to 120 centimetres high. Their yellow, red, or maroon flowers look like daisies and grow on slender stems. The leaves are often lobed (cut out). The flat fruits are small and dry and look like bugs. *Coreopsis* is the



Flowers of the *coreopsis* plant look like daisies and grow on slender stems. *Coreopsis* plants grow as high as 120 centimetres. Most cultivated types are yellow.

Greek word for *bug*. Most *coreopsis* plants are perennials and live for several years. But some are annuals and live only one season. *Coreopsis* are often grown as garden flowers. They grow best in a light soil in a sunny position.

Scientific classification. *Coreopsis* plants belong to the daisy family, Compositae (Asteraceae). They form the genus *Coreopsis*. A common annual is *C. calliopsidea*.

See also Flower.

Corfu. See Ionian Islands.

Corgi. See Cardigan Welsh corgi; Pembroke Welsh corgi.

Coriander is an annual herb that grows in the countries around the Mediterranean Sea. The plant is about 90 centimetres high and has small white flowers. Its seeds have a pleasant odour when ripe, and they taste sweet after they have been dried out. The seeds are used as a spice in curries, sauces, and liqueurs, and to make small round sweets. The leaves of fresh coriander are used by most Asian and Mediterranean countries for decorating food. Coriander-seed oil is used to flavour food, and as a medicine. About 250 kilograms of seeds yield 2.5 kilograms of oil.

Scientific classification. Coriander belongs to the parsley family, Umbelliferae (Apiaceae). It is *Coriandrum sativum*.

Corinth was one of the most important cities of ancient Greece. It was founded in prehistoric times on the isthmus that connects the Peloponnesus with the rest of Europe (see Greece, Ancient [map]). According to

Homer, it was the home of Bellerophon, Medea, and Sisyphus, figures of Greek legend.

Corinth was favourably situated for trade by land. It also had good harbours at Cenchreae and Lechaëum, on either side of the isthmus. By 750 B.C., Corinth had become the wealthiest city of ancient Greece. Except for two periods (454-404 B.C. and 146-44 B.C.), it maintained economic supremacy for about 1,300 years.

In 734 B.C., Corinthians founded colonies at Corcyra (now Corfu), an Ionian island west of Greece, and at Syracuse in Sicily. In 581 B.C., they instituted the Isthmian Games, an international festival held every second year. The games honoured their principal god, Poseidon. Corinth was famous for its skilled workers in bronze and clay, and for its naval architects. Because of commercial rivalry with Athens, Corinth was the chief instigator of the Peloponnesian War (see **Peloponnesian War**).

The Romans destroyed the city in 146 B.C., but later rebuilt it by order of Julius Caesar. Emperor Augustus made it capital of the Roman province of Achaëa. Saint Paul visited Corinth in A.D. 51 and founded a church there (see **Corinthians, Epistles to the**).

In the Middle Ages, the city was largely confined to its citadel, Acrocorinth. Archaeologists began excavations in Corinth in 1896.

Corinth Canal provides a waterway between the Gulf of Corinth and the Saronic Gulf in east-central Greece. The canal is 6 kilometres long. It cuts through the narrow strip of land that connects the peninsula of Peloponnesus with the rest of the Greek mainland.

A French company began building the canal in 1882, and Greece finished it in 1893. An attempt to build such a canal had been made by the Roman Emperor Nero in A.D. 67.

Corinthians, Epistles to the, are the seventh and eighth books of the New Testament of the Bible. They are letters from the apostle Paul to members of the Christian church he had founded in Corinth, Greece.

Paul wrote the first letter from Ephesus, in what is now Turkey, about A.D. 54. In the first half of the letter, he discussed problems that were reported to him orally, especially the problem of divisions within the church. In the rest of the letter, Paul discussed questions that the Corinthians raised in a letter they wrote to Paul.

Many scholars doubt that Paul wrote second Corinthians in the form in which we know it. They think that it consists of several shorter letters from Paul to the Corinthians that a later editor combined. Whether or not this is so, second Corinthians is mainly intended to repair the relationship between Paul and the Corinthians. Soon after Paul wrote his first letter, the Corinthians began to transfer loyalty to other apostles who had arrived in Corinth and seemed superior to Paul. The Corinthians questioned Paul's authority and sincerity. Paul wrote second Corinthians to persuade the Corinthians to accept him as they had done in the past.

See also **Paul, Saint; Bible** (Books of the New Testament).

Coriolanus, Gaius Marcius, was a general of the early Roman Republic. He was given his last name as a reward for his skill and bravery in capturing the town of Corioli from the Volscians, who were enemies of Rome.

During a famine in 491 B.C., Coriolanus suggested that no grain be given to the poor unless they gave up

their right to elect *tribunes* (representatives). The people became indignant over this, and exiled Coriolanus. He joined the Volscians to get revenge, and led their army to the gates of Rome. He was about to capture the city when his mother and wife persuaded him to spare Rome. The angry Volscians then killed Coriolanus. The playwright William Shakespeare told the story of this warrior in his tragedy of *Coriolanus*.

See also **Shakespeare, William** (*Coriolanus*).

Coriolis effect is the apparent effect of the earth's rotation on the motion of anything travelling across the face of the globe. The Coriolis effect is too small to be noticeable when a person walks or drives. But it greatly affects the paths of objects flying over the earth. For example, a missile travelling above the earth tends to move in a straight line. But, to an observer rotating along with the earth, the path of the missile appears to



The Corinth Canal cuts through a narrow strip of land in mainland Greece to connect the Gulf of Corinth with the Saronic Gulf. The canal brought greatly increased trade to the port of Piræus, which serves Athens, the capital of Greece.

curve, as if it were pushed. This apparent push is the *Coriolis force*. The Coriolis force prevents winds from the North and South poles and the equator from moving directly north or south. Winds that blow toward the equator seem to curve toward the west. Winds that move away from the equator seem to curve to the east. The Coriolis force also influences the direction of ocean currents.

See also **Air** (Air movement); **Weather** (General circulation of the atmosphere; diagram).

Cork is a coastal county in the province of Munster in the southwest of the Republic of Ireland. It is the largest of the Irish counties. It is noted for its varied scenery and has both remote rural settlements and large urban areas. The city of Cork is the second city of the Republic of Ireland in both population and economic importance.

People and government

Cork's population in 1986 was 3 per cent higher than it had been at the 1981 census. As in the Republic of Ireland as a whole, Cork's population had increased since about 1960. The largest rise had been in the 1970's. Population trends varied within the county. There was a decline in population in much of west Cork and in central parts of Cork city and many other towns. In contrast, there was major growth in the suburbs around the city of Cork and in the vicinities of the other larger towns. About 60 per cent of the population of County Cork lives in urban areas, with nearly half of the people living in and around Cork city.

About 94 per cent of Cork people are Roman Catholic. Most of the remainder are members of the Church of Ireland, but there are also Methodists, and some Presbyterians. Protestants are most numerous in the southwest of Cork. The county occupies three dioceses: Cork, Cloyne, and Ross. These are united under the Bishop of Cork in the Church of Ireland, with Protestant cathedrals in Cork (St. Finbarr's), Cloyne, and Ross Carbury. In the Roman Catholic Church, there are separate bishops for Cloyne and for Cork and Ross, with cathedrals in Cobh, Cork, and Skibbereen.

English is the everyday language of almost all Cork people. Many people speak Irish in Gaeltacht areas on Clear Island and along the middle of the western county boundary. For more information on the Gaeltacht, see **Irish language**. In the southwest, there is an annual religious pilgrimage at Gougane Barra, where St. Finbarr of Cork lived. In Cork city there are annual film and jazz festivals.

There are several institutions of higher education in Cork city. University College, Cork, is part of the Na-



County Cork has many scenic tourist attractions. The port of Kinsale, above, is popular for sailing and fishing.

tional University of Ireland. There is a regional technical college, and colleges of art, music, and commerce and technology.

Twenty members of parliament represent Cork in *Dáil Éireann* (the lower chamber of the Republic of Ireland's parliament). Half of them are elected from two constituencies in Cork city and its vicinity. The other half represent three constituencies in the remainder of the county. Cork city is a county borough with its own council. A county council is in charge of local government for the rest of County Cork. There are urban district councils in Clonakilty, Cobh, Fermoy, Kinsale, Macroom, Mallow, Midleton, Skibbereen, and Youghal.

Economy

One-sixth of the people of County Cork work in agriculture. The nature of farming varies in different parts of the county. Dairying is the leading activity, especially on grassland in the north and northwest. There is more mixed farming on the drier soils in the east and south, where arable crops grow. Barley for livestock feed is the main crop, but malting barley, potatoes, sugar beet, and wheat are also important. Farmers in the east and south rear beef cattle. In the southwest there is cattle rearing, dairying, and pig production. The amount of land used for crops and pasture on each farm in County Cork ranges from more than 30 hectares in the east to less than 15 in the west. The farmland in the west is much less fertile than that in the east.

About one-fifth of the county's people work in the manufacturing industry, and more than half of this is in the city of Cork, its harbour, and its adjacent areas. Industries in Cork city include baking, brewing, publishing, and the making of chemicals, clothing, computers, dairy products, electrical goods, furniture, paints, and textiles. Among large industries in the area of Cork harbour are chemical manufacture at Ringaskiddy, Carrigaline, and Little Island; fertilizer production at Marino Point; oil refining at Whitegate; and steelmaking at Haulbowline. Midleton is the centre of the Irish whiskey distilling industry. Mallow has sugar refining and dairy

Facts in brief about Cork

Population: 1991 census—409,814

Area: 7,460 km²

Largest towns: Cork, Cobh, Mallow, Midleton, Youghal, Carrigaline, Bandon, Fermoy

Chief products: Aquaculture—barley, cattle, milk, pigs, sugar beet. Other primary products—fish, peat, sand and gravel, stone, timber. Manufacturing—alcoholic drinks, chemicals, clothing, electronic and electrical goods, food products, printed materials, steel, wood products.

Origin of name: From the Irish *Corcaigh* (marsh)



Cork, a coastal county in the province of Munster, is the largest county in the Republic of Ireland.

processing. There are milk-processing plants in several other places, including Charleville and Mitchelstown. In County Cork as a whole, more than half of those employed in the manufacturing industries have jobs in light engineering and electronics, food processing, and chemical manufacturing.

Over half of the people of Cork work in service industries such as banking, education, health, insurance, public administration, retail and wholesale distribution, tourism, and transport. Many service activities are in Cork city. Tourism is important not only in the city but also along the coast, and especially in the scenic southwest of the county.

There has been much exploration for oil and natural gas off the Cork coast in the Celtic Sea. Natural gas was discovered and developed near Kinsale in the 1970s. A pipeline brings the gas ashore at Cork harbour and from there to Dublin and other parts of the country. Homes and factories use it, and two power stations in the harbour area generate electricity with gas. Two hydroelectric plants are on the River Lee.

Fishing is important along the Cork coast, especially in the west. Castletownbere is the third largest fishing port in the Republic of Ireland and has fish-processing industries. Other fishing ports include Baltimore, Bantry, Cobh, Kinsale, and Unionhall. There is much forestry in upland districts and a forest park at Gougane Barra.

Cork city is the hub of the county's road network. National primary routes radiate from it towards Waterford (N25), Dublin (N8), Limerick (N20), and Tralee (N22). Other major roads serve west Cork (N71) and the Blackwater Valley (N72). The main railway runs north from Cork city towards Dublin and Limerick. There are lines from Mallo to Tralee and between Cork and Cobh.

Cork harbour is a major commercial port. It has car and passenger ferry links with France and Wales. Formerly, many passenger ships crossing the Atlantic Ocean stopped at Cobh, and it was the main departure point for Irish emigrants sailing to North America. The Irish naval headquarters are at nearby Haulbowline. There is a deepwater oil terminal in Bantry Bay but it has not been used since 1979, when an explosion on a

tanker damaged it. Cork International Airport is to the south of the city.

Land

Cork's southern and main boundary is its indented Atlantic coast. Kerry bounds it to the west. Limerick to the north, and Tipperary and Waterford to the east. The greatest distance is 150 kilometres from northeast to southwest, and the average distance from north to south is about 70 kilometres.

The main feature of the landscape is a series of long valleys and ridges which run east to west. The major valleys are those of the rivers Blackwater, Bride, Lee, and Bandon. The valleys are broad in their lower sections but become narrower upstream and westwards. The valley floors are of limestone and shale.

The ridges are mainly sandstone. They rise westwards to over 500 metres in height in the Boggeragh, Derrynasaggart, Shehy, and Caha mountains. The ridges bend southwestward to form peninsulas separated by the long sea inlets of Bantry and Dunmanus bays. The rugged coast of west Cork backed by hills is very beautiful.

The southwest coast of Cork is in the mildest part of Ireland. Grass may grow throughout the year and there are some subtropical plants. The average January temperature there is 7° C. In the northeast of the county, it is 5° C. July temperatures average 16° C. Annual rainfall is 200 centimetres on the mountains of the west and less than 100 centimetres in the southeast.

History

Stone Age monuments, fortified farm enclosures, and early Christian sites show the long history of human settlement in Cork. St. Finbarr had a monastery there in the A.D. 600s. The Vikings established the town of Cork as a trading centre in the 900s. An Irish family called McCarthy ruled over the kingdom of Desmond, the southern part of Munster, a region now occupied by the counties of Cork and Kerry. After the Anglo-Norman invasion, much of this territory was granted to the Fitzgeralds. As earls of Desmond, they became increasingly Irish.

Cork city remained a centre of English power. In the late 1500s, there was an attempted *plantation* (settlement) of Munster by English colonists. The most famous person to receive land was Sir Walter Raleigh, who was granted territory at Youghal. The Irish lost the battle of Kinsale in 1601. During the 1600s Richard Boyle, earl of Cork, became very powerful.

The castles, fortified houses, and mansions of Cork are its most notable buildings. The most famous castle is at Blarney, where people believe that the Blarney Stone confers the gift of eloquent speech on those who kiss it (see **Blarney Stone**). The Charles and James forts in Kinsale date from the 1600s. The towns of Kinsale and Youghal were founded by the Anglo-Normans, but most other towns in Cork were founded by the English colonists planted in the region in the 1500s and 1600s. The county played a prominent part in the War of Independence and the Civil War of the early 1920s.

Among writers from Cork are Frank O'Connor, Sean O'Faolain, and Somerville and Ross. Famous people who lived in the county for some time include the writer Edmund Spenser, the philosopher George Berkeley.

and the temperance leader Father Theobald Mathew.

See also Ireland.

Cork (pop. 127,024) is the second largest city of the Republic of Ireland. Only Dublin, the capital, has more people. Cork is also the Irish Republic's second most important city—after Dublin—in such activities as manufacturing and trade and in education, medicine, and other services. Cork lies in southern Ireland, at the northwest end of Cork Harbour. For location, see *Ireland* (map). The central part of the city is on an island between two branches of the River Lee. The rest of Cork spreads over hilly land north and south of the river.

Cork's location on an island and amongst hills gives the city a picturesque appearance. Cork has several beautiful churches, including St. Mary's Cathedral and St. Finbar's Cathedral. University College is in the city.

Cork is an exporting and importing centre. Goods manufactured in the Cork area include alcoholic beverages and processed foods, chemicals, electronics products, petroleum products, steel, and textiles.

Vikings established Cork in the 800's, though a small settlement had previously been on the site. Cork grew rapidly during the 1700's, when its merchants established industries that processed agricultural products and handled goods being exported and imported. At that time, the originally swampy island was drained and became the core of the city. Cork later grew to include higher land north and south of the island. Cobh, a town near Cork, became the main port of departure for Irish emigrants sailing to North America in the 1800's.

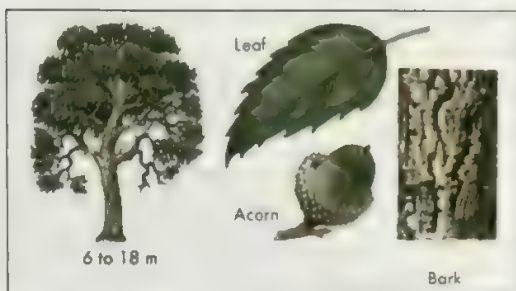
See also Munster.

Cork is a lightweight, spongy substance obtained from the bark of the cork oak tree. It does not absorb water readily and can be compressed a great deal, but it springs back when released. People used cork as early as 400 B.C. The Romans wore cork sandals and used cork to float anchors and fishing nets. Cork bottle stoppers have been made since the 1600's.

The tree. The cork tree is a live oak. This means that it is green all the year round. It grows abundantly in Portugal and Spain, where most of the world's cork is produced. Italy is the third most important country in cork production. The cork oak has been planted in parts of California, U.S.A., and in India. The outer layer of the bark is dead and is separated from the live inner bark by



Cork comes from the bark of the cork oak tree. Workers remove the bark and let it dry in the sun. Cork is used for wall coverings, notice boards, and many other products.



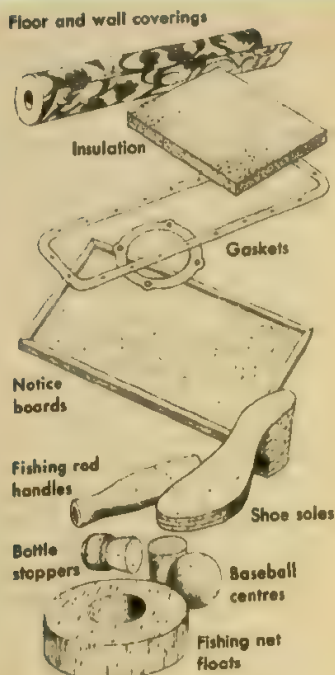
The cork oak tree provides most of the world's supply of cork. The cork is made from the tree's bark. The bark is stripped away every 8 to 10 years without damaging the tree.

a layer of water-resistant cells called the *phelloderm*. These cells have thin walls that become thickened and waxy. The cork tree lives from 300 to 400 years, but it seldom grows more than 15 metres high.

Gathering cork. A cork tree must be about 20 years old before its bark is thick enough to be stripped. The first layer removed is called *virgin bark*. Workers strip the bark in June, July, and August. Each tree can be stripped about once every 8 to 10 years. The best cork comes after the tree has been stripped twice.

A cork stripper uses a long-handled hatchet to cut long, oblong sections of bark from the top of the lowest branches to the bottom of the tree. The sections of bark are prized off carefully with the wedge-shaped handle of the hatchet. New phelloderms continue to form so

Some uses of cork



that more cork is produced after each stripping. Cork will never grow again on a spot where the stripper's hatchet has damaged the live inner layer of bark down to the *cambium*. Cells in this tissue divide to form new layers of wood and bark cells.

Preparation for market. The slabs of stripped cork are boiled, and a rough, gritty outer layer is scraped off. The boiling dissolves tannic acid from cork, and softens the material so that the slabs can be straightened out and packed in bundles. Before being loaded on ships, cork is sorted according to quality and thickness.

Uses. Most cork is used for insulation. For this purpose, it is ground and pressed into boards and pipe coverings. In this form, cork covers the walls and freezing pipes of thousands of cold-storage plants, meat-processing factories, ice-cream factories, and oil refineries. Cork floats in water, and is used in making buoys and floats for fishing nets. Linoleum is made by mixing cork powder with linseed oil and spreading this paste over canvas or burlap. Floors, walls, and ceilings are made soundproof with corkboard. One of its principal uses is for "corks," or bottle stoppers. Thin cork gaskets seal metal bottle caps. In addition, cork is used in water-proof coatings, in balloon fabric, and as wadding for shotgun cartridges. Cork shavings are burned to make *Spanish black*, or *cork black*, a paint used by artists.

Scientific classification. The cork oak tree is in the beech family, *Fagaceae*. It is *Quercus suber*.

See also **Bark; Insulation; Oak; Tree (Parts)**.

Corn is a short, thick underground stem. The main function of a corn is food storage. During the growing season, the corn stores food made by the plant's leaves. At the end of the growing season, the aboveground parts of the plant usually die, but the corn stays alive. The next spring, new aboveground stems and leaves are formed, using the food that the corn has stored all winter. A new corn then develops above the old one, and the old corn dies. The new corn continues to grow as it, in turn, stores food.

Tiny corms, called *cormels*, grow out of the main corn. Gardeners separate the cormels from the corn and plant them. The cormels then grow into new plants.

Corms resemble bulbs in size and shape, but their internal structure is different. Bulbs consist mainly of fleshy leaves, but a corn is mostly stem tissue, covered by thin leaves. Gladiolus and crocus are well-known plants with corms.

See also **Bulb; Stem**.

Cormorant is a large, web-footed bird that catches fish by diving under water. Cormorants are found throughout the world. Most of them live on seacoasts, but they are often seen on large rivers and lakes. Cormorants are related to pelicans. There are about 30 species of cormorants. The large kinds measure more than 75 centimetres long. All types of cormorants have long, powerful hooked bills. Most species of cormorants are strong fliers, and all are excellent swimmers.

The largest and most common species is the *common* or *great cormorant*, which has white cheeks and is about 90 centimetres long. It breeds in close colonies from eastern Canada, across Eurasia to Australia and New Zealand. The common cormorant usually builds its nest on the ledge of a cliff. The nest is made of twigs and seaweed. The North American *double-crested cor-*

morant is named after the crest of white, curved head feathers that develop during the breeding season. It also has an orange throat. *Japanese cormorant* is the species that has been trained to fish. The *Peruvian cormorant* is an important producer of guano fertilizer. See **Guano**.

Cormorants look for fish while swimming on the water's surface. When they spot a fish, the birds dive below the surface and swim underwater with powerful kicks of their webbed feet. Cormorants usually return to the surface to eat their catch. Fishermen in southeast Asia train the *Japanese cormorant* to fish for them.

Scientific classification. Cormorants belong to the pelican family, *Phalacrocoracidae*. The common cormorant is *Phalacrocorax carbo*, the double-crested cormorant is *P. auritus*, the Peruvian cormorant is *P. bougainvilli*, and the Japanese cormorant is *P. capillatus*.

See also **Pelican**.

Corn is a small, hard, shiny thickening of the *epidermis* (outer layer of the skin). This thick growth presses on the *dermis* (deeper skin layer) and causes it to become thin and tender. Pressure and friction cause corns. Therefore, corns often develop over the joints of the toes of persons who wear shoes that do not fit properly. But corns may form anywhere on the body where pressure and friction injure the skin. A *soft corn* is one located between the toes. Here the thickened skin remains soft because it is constantly bathed with sweat.



Common cormorant



The cormorant dives into the water to catch fish and returns to the surface to eat them. This photo shows a double-crested cormorant about to swallow a fish.

Corn plasters remove the thickened epidermis and are used to relieve the pain of corns. Most plasters contain chemicals that soften the outer horny accumulation. To cure a corn, the things that caused it to form must be removed. Because of the danger of infection, paring corns with sharp instruments should be done only by a doctor.

See also **Callus**.

Corn. See **Maize**.

Corn borer, also called the *European corn borer*, is a serious insect menace to maize crops. The borer is the larva of a night-flying moth. It is pinkish with small brown spots. The female moths begin to lay eggs on maize leaves in early June. The tiny borers feed on the young leaves and tassels. As they grow larger, they feed on the stems and ears. One or more generations of borers appear each year, depending on the length of the growing season. In winter, the larvae live in old corn-cobs, stems, and stubble. The corn borer prefers to eat maize and sorghum. But it attacks other plants, including celery, potatoes, beans, flowers, and weeds.

In temperate regions, farmers destroy corn borers during the winter by feeding cornstalks to livestock, or by shredding or burning the stalks. They plant late in the season to avoid the first flight of the moths, and use hybrid maize plants that are not affected by the corn borer. In some cases, farmers use insecticides.

The European corn borer was introduced to North America in about 1910, and since then it has spread and caused great damage. Other species of corn borers are pests in Africa, Asia, and Australia.

Scientific classification. The European corn borer belongs to the snout moth family, *Pyraustidae*. It is *Ostrinia nubilalis*.

Corn flour. See **Cornflour**.

Corn Laws were measures passed in England between the 1400's and mid-1800's to control the price of small grains, called *corn* in England. The first Corn Laws prevented grain exports. By the 1500's, landowners could export grain if English prices fell too low. As the population grew in the 1700's, grain imports were permitted if prices rose too high.

By the 1830's, industry was developing in Great Britain, and support grew for the free trade proposals of economist Adam Smith. Landowners had lost support in Parliament. The Anti-Corn Law League, a group of factory owners and workers, wanted the laws repealed so bread would be cheaper. Parliament repealed the Corn Laws in 1846. Food imports then increased, and British agriculture declined.

See also **Peel, Sir Robert**.

Corn oil is a vegetable oil made from the kernel of the maize plant. It is used mainly as a cooking and salad oil and in such food products as margarine and potato crisps. Refined corn oil has a pale, yellow colour.

During processing, machines separate the *germ* (embryo) from the rest of the kernel. The germ contains about 20 per cent oil. The oil can be squeezed from the germ, or it can be obtained by *solvent extraction*. This method involves treating the germs with a liquid solvent, which separates the oil from the germ. Corn oil consists of about 55 per cent polyunsaturated fat, a substance many nutritionists consider essential to a healthy diet (see **Fat**). The United States produces most of the world's corn oil.

Corn syrup is a thick, sweet liquid made from corn flour. Food processors use it to sweeten baked goods, sweets, tinned fruits, and many other foods. Corn syrup gives creams and sweets a smooth texture. It also attracts and holds moisture, and so it helps prevent baked goods from becoming stale.

Manufacturers make corn syrup from a mixture of cornflour and water. They add a weak acid solution or certain *enzymes* (protein molecules) to the mixture and then cook it under pressure. The resulting corn syrup consists mainly of two sugars, *glucose* and *maltose*, plus a sticky substance called *dextrin*. To make a sweeter syrup, manufacturers add another enzyme, which changes some of the glucose in the syrup to a sweeter sugar called *fructose*. Further treatment of the syrup produces *high-fructose corn syrup* (HFCS). HFCS costs less and is much sweeter, but not higher in calories, than other sweeteners.

See also **Sugar**.

Corncrake. See **Crake**.

Cornea. See **Eye** (The sclera and the cornea).

Corneal transplantation. See **Eye bank**.

Cornille, Pierre (1606-1684), was a French playwright. He is often called the father of French tragedy, but he is more truly the founder of French heroic comedy. Cornille favoured tragicomedy and melodrama over the conventional tragedy of his day.

Cornille is best known for his tragicomedy *The Cid* (1636 or 1637). The French Academy condemned the play for breaking several "classical" rules. These rules held that a play should consist of a single plot in a single location within a day's time. Violence was also prohibited on stage. Although *The Cid* broke these rules, it enjoyed great popularity. It was the first French drama to centre on the characters' inner psychological conflict rather than on details of the plot. It also brought to the French stage a new lyrical language in keeping with the passionate nature of Cornille's heroes.

The subjects of most of Cornille's plays are taken from Roman history. Most of his leading characters, like their ancient models, show great pride, patriotism, honour, and stern courage. They are fearless, remorseless, and subject to violent emotions such as hatred, revenge, and superhuman ambition. Many of Cornille's plays show the effect of Spanish drama, especially in the passionate, arrogant, and violent nature of their heroes.

Cornille's other famous plays include *Horace* (1640), *Cléopâtre* (1640), *Polyeucte* (1642), and *Rodogune* (1644). He described his drama theories in the prefaces to his plays and especially in his *Discourses on Tragedy* (1660). Cornille was born in Rouen, France.

Cornelian is a red or reddish-brown quartz which can be cut and polished as a jewel. This gem is sometimes called a *carnelian*. Most cornelian comes from India, South America, and Japan. It is used in rings, bracelets, and other jewellery.

The cornelian was one of the first stones to be used as a decoration. People of ancient times believed the cornelian had special powers that would protect its wearer from weapons and evil spirits. Muhammad wore a ring with a cornelian stone to seal important papers.

See also **Chalcedony**; **Gem**.

Cornell, Ezra (1807-1874), was an American businessman and philanthropist. He rose with the rapidly grow-

ing telegraphic communications industry, and helped organize the Western Union Telegraph Company. He became wealthy, and in his later years devoted his energies and fortunes to educational projects. He is particularly remembered for helping found Cornell University.

Cornell was born in New Britain, New York. His father was a poor potter, and he received little education. After several false starts in various fields, Cornell invented a machine that solved Samuel Morse's problem of laying cable for his first telegraph line. Cornell then went on to become one of the leading builders of telegraph systems.

Cornet is a brass musical instrument that resembles a shortened trumpet. Cornets and trumpets have the same range, but the cornet has a mellower tone quality. The main part of a cornet is a coiled tube about 1.5 metres long. The tube has three valves. Different pitches are produced by vibrating the lips in a cup-shaped mouthpiece. Notes are played by changing the tension of the lips and by pressing the valves.

The cornet developed from a valveless brass instrument called a posthorn. The modern cornet appeared after valves were invented in the early 1800's. The instrument soon became the main melodic brass instrument in bands. Some composers also wrote cornet parts for symphony orchestras, often in combination with trumpets. Because of its brilliant tone and carrying power, the trumpet has almost completely replaced the cornet in jazz groups, concert bands, and marching bands.

See also **Trumpet**.

Cornflour is a fine white flour made by grinding and refining grains of maize. It is made of maize from which the seed-bearing part, called the *germ*, has been removed. The maize is ground in a process called *wet milling*. After removal of the maize proteins, the remaining cornflour is dried in ovens. Since only 10 per cent of moisture remains in the cornflour after drying, it is often mixed with other foods to protect them from moisture. Manufacturers use cornflour in bakery products, baking powder, sweets, and salad dressing. Cooks use it to thicken gravies and puddings. Manufacturers also use cornflour in explosives, paints, and textiles. See also **Maize** (The wet-milling industry).

Cornflower is a plant that bears small flowers shaped like buttons. Usually the flowers are blue, but some varieties have pink, purple, or white blossoms. The flowers measure 2.5 to 4 centimetres across. Cornflowers are *annual* plants—that is, they live for only one year. The plant, which blooms from June to September, grows up to 60 centimetres tall and has long, narrow leaves. White, cottony hairs cover the leaves and young stems.

The cornflower grows wild in Europe, north of the Mediterranean Sea. It gets its name because, before the widespread use of *herbicides* (weed killers), it was common among fields



Cornflowers

of corn. Cornflowers are also called *bachelor's-buttons* or *bluebottles*.

Cornflowers are grown in gardens and also for the cut-flower market.

Scientific classification. The cornflower belongs to the daisy family, Compositae (Asteraceae). It is *Centaurea cyanus*.

Cornucopia is a horn of plenty, a symbol of nature's productivity. According to Greek mythology, it was one of the horns of Amalthea, the goat who nursed the god Zeus when he was a baby. The horn produced ambrosia and nectar, the food and drink of the gods. In Roman mythology, the cornucopia was the horn of the river god Achelous. The hero Hercules broke off the horn in combat with Achelous, who was fighting in the form of a bull. Water nymphs filled the horn with flowers and fruit and offered it to Copia, the goddess of plenty.

Cornwall is the most southwesterly county in England. Millions of tourists enjoy its warm climate and beautiful coastal scenery. Tourism is the county's main industry. It also has an important agricultural and horticultural economy. The mild climate helps the early ripening of basic food crops and flowers. Cornwall has its own historic culture and character. Many large Cornish estates belong to the eldest son of the reigning monarch. They form a large part of the Duchy of Cornwall.

People and government

The only Cornwall towns with more than 20,000 population are St. Austell and the adjoining industrial towns of Camborne and Redruth.

Customs and language. Cornwall's rugged coast has given rise to many legends of shipwrecks, pirates, and mermaids. Other legends relate to Celtic saints or to King Arthur.

Cornwall has its own Celtic language, related to Welsh. Though few speak the language now, interest in it has revived in recent years. At the annual *Gorsedd*, the Grand Bard presents awards for poetry and songs in Cornish.

Recreation. Most of the well-known British sports are played in Cornwall. Among the most popular are sea sports. Cornwall has good fishing facilities, both in fresh water and more particularly in the sea.

Cornwall has its own version of the Celtic game of *hurling*. A game takes place at St. Columb Major, near the town of Wadebridge, on Shrove Tuesday and the Saturday 11 days later.

Local government. Cornwall has six districts for administration: *Caradon*, including Saltash and Liskeard; *Carrick*, including Falmouth and Truro; *Kerrier*, including Camborne-Redruth and Helston; *North Cornwall*, including Bodmin and Bude; *Penwith*, including Penzance and St. Ives; and *Restormel*, including Newquay and St. Austell. The county council provides some public

Facts in brief about Cornwall

County town: Bodmin. County Hall is in Truro.

Largest towns: Camborne-Redruth, St. Austell, Penzance, Falmouth, Truro, Newquay, Saltash, Bodmin.

Area: 3,545 km²

Population: 1991 census—469,300 (including Scilly Isles).

Chief products: Fish, flowers, granite, kaolin, slate, tin, vegetables.

Motto: One and All.

services throughout the county. The Scilly Isles are partly under Cornwall's administration (see *Scilly, Isles of*). Cornwall and Devon are covered by a single police force, which has its headquarters at Exeter in Devon. The crown court meets at Truro.

Economy

Agriculture and fishing. Agriculture is an important part of the Cornish economy. Most of the farms are small, and specialize in dairy and beef cattle. Pigs and poultry are kept in large numbers. Farmers in the north and east of the county grow some cereal crops. Market gardening is important in southern Cornwall. Newlyn is the county's main centre for fishing.

Mining and quarrying. Tin mining, once important, declined after World War I, because of competition from overseas. But new interest grew in Cornish tin mines from the 1960's until the 1980's, when falling prices caused mine closures. China clay is quarried, mainly in the St Austell area. Quarries near Penryn produce granite, used in many public buildings.

Tourism is one of the county's leading industries. Newquay is the largest resort.

Manufacturing. Many of Cornwall's manufactures are linked with the other local industries—agriculture, fishing, mining and quarrying, and tourism. The Camborne-Redruth industrial area exports mining and quarrying equipment to all parts of the world. Falmouth has a large ship-repairing yard. Boats are built in many Cornish yards, nets are made in Porthleven, sails at Falmouth and Penryn, and surfboards at Newquay.

Transportation and communication. The main road from London, the A30, enters Cornwall near Launceston and runs to Land's End. Another major road links northern Cornwall with northern Devon. In the south, a road crosses the Tamar Bridge to connect Cornwall with Devon. A main railway line from London runs along the county, terminating at Penzance, with branch lines to coastal resorts. Newquay airport has three flights a day to and from London's Heathrow Airport. A satellite com-



Newlyn, the main centre of fishing in Cornwall, also has businesses supporting the industry, such as boat repairing

munications station at Goonhilly, on the Lizard peninsula, transmits television programmes from the United Kingdom to many parts of the world. The terminals of the transatlantic telephone and telegraph cables are at Porthcurno, near Land's End. BBC Radio Cornwall operates from Truro, and Pirate F.M., a commercial station, broadcasts from Redruth. Several towns have weekly papers.

Land

Location and size. Cornwall is a peninsula at the extreme tip of England. It contains the most southerly point on the mainland of the United Kingdom (the Lizard), and the most westerly point on the mainland of England (Land's End). Cornwall has a longer coastline than any other English county. It is 580 kilometres long.

Land features. The most prominent natural features inland are four large outcrops of granite. These are areas of gaunt moorland and steep hills. They are Bodmin Moor, in east Cornwall; Hensbarrow to the west; the area around Camborne-Redruth; and the Land's End peninsula. These areas are rich in minerals. A fifth granite outcrop rises above the sea as the Isles of Scilly.

The lowlands are mainly agricultural and horticultural areas, except the Lizard peninsula, which is moorland. Much of the south coast is an area of rolling hills, fields, and woodlands, with picturesque *coves* (bays). The north coast is mainly a stretch of tall cliffs. At their base lie many fine beaches. The two highest Cornish hills are Brown Willy, 419 metres, and Rough Tor, 400 metres, both on Bodmin Moor.



Cornwall is a county in England occupying the most southwesterly point of the country.

Places to visit

Following are brief descriptions of some of Cornwall's interesting places to visit:

Bodmin Moor is a wild upland area. Jamaica Inn, long associated with smugglers, stands on the moor.

Lizard Point has magnificent cliffs and a lighthouse built in 1752. Kynance Cove, nearby, is famous for its beautifully coloured rocks.

St. Agnes is one of Cornwall's oldest tin-mining villages. Many derelict engine houses of the old mines lie near the village. In St. Agnes is a miniature Cornish village.

St. Michael's Mount, a little island near Marazion, has a castle on the site of an ancient monastery.

Tintagel is connected by legend with King Arthur. But its castle, now in ruins, dates from the 1100's.

Trengwainton Gardens, near Penzance, has many subtropical plants that will not grow outdoors anywhere else in England.

Zennor, southeast of St. Ives, has a museum of Cornish crafts and industries. Zennor Quoit is a chambered tomb that was built in about 2000 B.C.

Most Cornish rivers flow south to the sea. An exception is the River Camel, which enters the Atlantic at Padstow. The county's rivers include the Tamar, the Looe, the Fowey, the Fal, and the Helford. The Fal estuary, at Falmouth, is one of the world's largest natural harbours.

Climate. The weather is moderated considerably by the warm Gulf Stream current. The average February temperature is about 8° C. The average August temperature is about 16° C. The rainfall in Cornwall averages about 1,140 millimetres a year.

History

The Celtic peoples of Britain were isolated in the remote western regions by the invading Anglo-Saxons from A.D. 400. The legendary King Arthur is believed to have been a Celtic leader of this period. The Christian Cornish people maintained their own culture and had little to do with the pagan English at first. But gradually, they took more part in national life, though they continued to use their own language until the 1700's.

It was probably mining for tin and copper that established Cornwall's importance. The metals were worked more than 2,000 years ago, but deep mining did not develop until the 1700's. Cornwall then produced many fa-

mous engineers and scientists. Richard Trevithick invented the steam locomotive. Sir Humphry Davy invented the miner's safety lamp, and Henry Trengrouse designed a rocket life-saving apparatus.

Famous people associated with Cornwall include the painter John Opie, the writers Sir Arthur Quiller-Couch and Daphne du Maurier, the poet Charles Causley, and the historian A.L. Rowse.

Related articles in *World Book* include:

Arthur, King

Celts

Cornwall, Duchy of

Davy, Sir Humphry

Du Maurier (Daphne)

Land's End

Opie, John

Penzance

Quiller-Couch, Sir Arthur

Rowse, A.L.

Saint Michael's Mount

Scilly, Isles of

Trevithick, Richard

Truro

Cornwall, Duchy of, consists of estates granted to the monarch's eldest son, who receives the revenue from the estates after he is 21. The estates are in Cornwall, Devon, Somerset, and elsewhere in the southwest of England. Charles, Prince of Wales, is the present Duke of Cornwall. The duchy was instituted in 1337 by Edward III for his son Edward, the Black Prince. The duchy was rich because of its tin mines.

Cornwallis, Charles (1738-1805), the first Marquis Cornwallis, was a British general in the American Revolution. The surrender of his troops at Yorktown, Virginia, in 1781 was critical to the American triumph.

Cornwallis helped capture New York in 1776, then pursued General George Washington across New Jersey. He became second in command to Sir Henry Clinton in 1778. In 1780, he took charge of the Southern campaign. Invading North Carolina, he won a costly victory in 1781 at Guilford Courthouse against forces of General Nathanael Greene. Then, against Clinton's wishes, he moved into Virginia. A French fleet and French and American troops surrounded him at Yorktown. He surrendered there on Oct. 19, 1781.

Cornwallis was commander in chief and viceroy of India from 1786 to 1793 and again in 1805. He also served as lord lieutenant and commander in chief of Ireland from 1798 to 1801. Cornwallis was born in London.

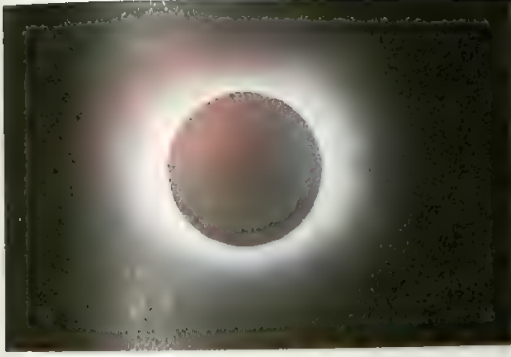
Cornwallis, Edward (1713-1776), a British soldier and colonial official, led 2,500 settlers to Nova Scotia, in Canada, in 1749 and founded the city of Halifax. The city became Nova Scotia's capital in the same year. After overseeing its initial settlement and establishing civil government, he served as governor and captain-general of Nova Scotia from 1749 to 1752. Cornwallis served in the British army from 1731 to 1748. He was governor of Gibraltar from 1762 until his death. Cornwallis was born in London.

Corona is the outermost layer of the sun's atmosphere. It is visible to the unaided eye only during a total solar eclipse, when the rest of the sun is hidden by the moon. At such times, the corona appears as an irregularly shaped halo of light (see **Sun**).

The corona consists chiefly of electrons, hydrogen ions, and ions of heavier elements that have lost many of their electrons. Such highly ionized atoms result because of the corona's high temperature, estimated at about 2,200,000° C. The corona has an extremely low density. At its densest, near the solar surface, the corona has only about 1 billion particles per cubic centimetre. The density rapidly decreases outwards.



Fowey is one of several picturesque towns located on the coast of Cornwall.



The corona, as seen during a total solar eclipse

The corona is continually expanding into space, forming the *solar wind*. This stream of charged particles extends to the earth's orbit and beyond. Astronomers believe the solar wind flows primarily from *coronal holes*, which are regions of relatively low temperature and density in the corona. These coronal holes occur mainly around the sun's poles, but they sometimes appear at lower solar latitudes.

The corona has a very irregular shape. Streaks of coronal gas called *polar tufts* spread outward from the sun's poles, and long, gaseous rays known as *coronal streamers* radiate from areas closer to its equator. The gas is guided by the sun's magnetic field, and so the co-

rona takes on different shapes as the field changes.

Between eclipses, astronomers rely on instruments called *coronagraphs* to study the corona. A coronagraph is a special telescope in which a small disc placed in the focus blocks the light from the solar disc. Coronagraphs on certain mountains enable them to observe the inner corona. During the 1970's and early 1980's, spacecraft equipped with coronagraphs provided observations of the outer corona. Data from the space station *Skylab* revealed that the corona is far more active than was previously believed. Violent coronal eruptions occur frequently during the maximum phases of the *sunspot cycle* (see *Sunspot*). Data from the *Solar Maximum Mission* satellite confirmed this condition. X-ray telescopes on orbiting satellites also showed the sun's corona. X-ray observations from other satellites indicated that most stars have coronas too.

Coronado, Francisco Vázquez de (1510-1554), was a Spanish explorer. Coronado led an expedition into the American Southwest in search of the legendary Seven Cities of Cibola. Indians and earlier Spanish explorers had reported these cities to be rich in gold. Coronado found Indian villages but did not discover any golden cities.

Coronado was born in Salamanca, Spain. He left home after his wealthy parents promised the family fortune to his older brother. In 1535, Coronado sailed to Mexico with Antonio de Mendoza, the viceroy of Mexico. Coronado became governor of New Galicia province, northwest of Mexico City, in 1538.



The Surrender of Lord Cornwallis at Yorktown (1817-1824), an oil painting by John Trumbull. Yale University Art Gallery, New Haven, Connecticut, U.S.A.

Lord Cornwallis surrendered his army to George Washington at Yorktown. This painting shows French and American officers, including Washington, lined up to receive the surrender.

In 1536 and 1539, Spanish explorers told Mendoza about the Seven Cities of Cibola. Mendoza chose Coronado to command an expedition to find the golden cities and claim their wealth for Spain.

In 1540, Coronado set out from Compostela, the capital of New Galicia, with about 300 Spanish soldiers and a large number of Indian troops. He led his army into the area that became Arizona and New Mexico, U.S.A. He found a group of Zuni Indian settlements, which he identified as Cibola, in the area of what is now Gallup, New Mexico. Coronado captured the Zuni villages, but he found no sign of gold or other riches.

While Coronado's army camped in the villages of Cibola, some of his men made separate trips in search of golden cities. One group visited the Pueblo Indian villages of Acoma, Pecos, and Taos in what is now New Mexico. They also were the first Europeans to travel up the Rio Grande Valley. Another group found Indian settlements in Arizona, and the members of a third band became the first Europeans to reach the Grand Canyon.

Coronado and his army spent the winter of 1540 in Tiguex, a Pueblo village on the Rio Grande. In the spring, he led his army south across what is now Texas. He then went into present-day Kansas in search of Gran Quivira, a land reported to be rich in gold and silver. He was the first European to reach Palo Duro Canyon near

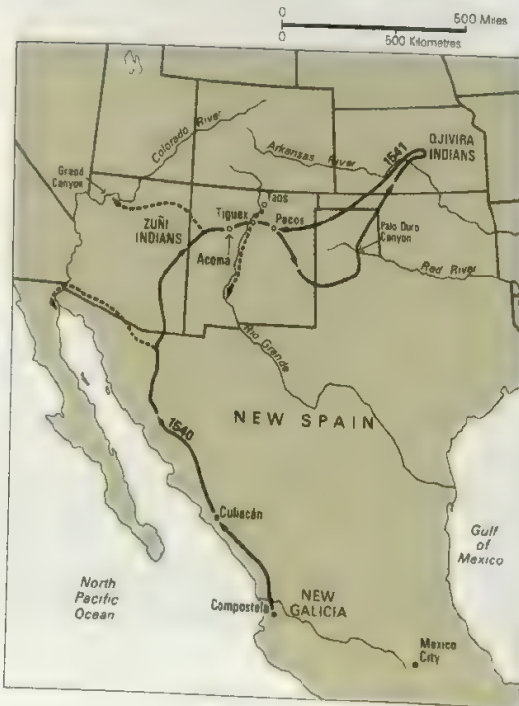


Francisco Coronado, shown in a painting by N. C. Wyeth, set out in 1540 to search for seven cities that were said to be stocked with gold and gems. Instead, he reached parts of the Rio Grande and central Kansas.

Coronado's expedition 1540-1542

The map below shows the explorations of Francisco Coronado in the American Southwest. Coronado searched in vain for the legendary cities of Cibola and Gran Quivira. The present-day state boundaries are also shown.

- Route of main expedition
- - - - Route of secondary expedition
- Indian pueblo
- Spanish settlement



what became Amarillo, Texas. North of the Arkansas River in Kansas, Coronado found settlements of Quivira Indians, but no gold. Discouraged, he finally returned to Tiguex during the winter of 1541 and later went home to New Galicia. In 1546, Coronado was accused of cruelty against Indians in his army, but he was found innocent.

See also Cibola, Seven Cities of.

Coronary thrombosis, also called *coronary occlusion*, is a condition in which a clot blocks the passage of blood in an artery of the heart. The portion of the heart muscle supplied by the blocked artery then dies. The death of the muscle is called a *heart attack* or a *myocardial infarction*.

Symptoms of a coronary thrombosis include severe chest pain, shortness of breath, vomiting, and a weak and rapid pulse. A coronary thrombosis can cause death. If the patient survives, the condition leaves scar tissue in the area of the heart muscle supplied by the artery where the clot developed.

See also Heart (Arteriosclerosis; Heart attacks).

Coronation is a ceremony at which a king, queen, or pope publicly receives a crown as a symbol of rule. The ceremony is usually rich in colour and tradition. Most coronations have religious as well as political features, and a religious official often performs the ceremony. During the proceedings, the new ruler also receives other official marks of royalty.

The British coronation includes many features common to coronation ceremonies in other countries. The British ceremony takes place in Westminster Abbey, London. The new monarch is conducted from the west door of the Abbey along the nave to the crossing, where the ceremony is performed. First, the monarch sits in a Chair of Estate. The *regalia*—the crown, orb, sceptre, rod, swords of state, spurs, ring, and bracelets that are used in the ceremony—are placed on the altar. The Archbishop of Canterbury then presents the monarch to the people in the abbey as the true ruler of the realm. The monarch takes the coronation oath, swearing to rule justly and to support the Church of England. The monarch receives a Bible, which is placed on the altar. The celebration of the communion service of the Church of England then begins.

The service is interrupted after the Creed, the cloak is removed, and the monarch moves to King Edward's Chair, also called the Coronation Chair. Here the monarch is anointed and clothed in a cloak of gold cloth. The spurs of St. George, a symbol of knighthood, are presented. The Sword of State is taken from its scabbard and carried before the monarch during the rest of the ceremony. *Armills* (bracelets) are put on the wrists of the monarch. While sitting in King Edward's Chair, the monarch receives the *orb*, a globe of gold surmounted with a cross signifying the rule of Christ over the world. The Coronation Ring, symbolizing the marriage of the ruler and the kingdom, is placed on the monarch's right hand. The monarch receives a rod with a dove to hold in the left hand. The dove symbolizes the Holy Ghost. The monarch holds a sceptre with a cross in the right hand. On top of the sceptre is the *Star of Africa*, the largest cut diamond in the world. After the monarch receives these symbols of authority, the Archbishop of Canterbury places the crown of St. Edward on the monarch's head.

From the Tower of London guns fire a salute in honour of the coronation. The peers and peeresses (members of the House of Lords), who were bareheaded until this moment, place their coronets and caps on their heads. The monarch moves to the throne after receiving a blessing from the archbishop. Nobles, carrying the Jewelled Sword of State, the Sword of Temporal Justice, the Sword of Spiritual Justice, and the Sword of Mercy, which has a blunted point, surround the throne. The monarch gives the rod and sceptre to an attendant, then receives homage and fealty from representatives of the clergy and the public.

The monarch then leaves the throne, removes the crown, and offers the archbishop the bread and wine for Holy Communion. An altar cloth and an ingot of gold are placed on the altar. The monarch takes Holy Communion and returns to the throne. Then the monarch receives the crown, the sceptre, and the orb, and leaves the throne. After walking in procession down the nave, the monarch leaves the Abbey through the west door. A

ceremonial procession, in which the monarch drives through the crowds in the city streets, follows. A banquet is held to mark the coronation. In earlier times a fully armed knight, the King's Champion, rode into the banquet hall to challenge anyone who questioned the monarch's right to the throne.

The British coronation ceremony is quite ancient. The earliest record of the ceremony used in the coronation of an English king dates from about the A.D. 750's. King Edward I (1272-1307) ordered the Coronation Chair made to contain the *Stone of Scone* (or *Stone of Destiny*), the Coronation Stone of kings of Scotland. The most recent British coronation, in 1953, was that of Queen Elizabeth II. It was the first to be shown live on television. Leaders from all over the Commonwealth, and from other nations, attended the ceremony.

Development. Ancient Germanic tribes elected their rulers. The newly elected king received a spear, and a diadem of silk or linen was placed on his forehead. As the king sat upon a shield, his warriors lifted him to receive the acclamation of his followers.

Religious pageantry, taken from the Bible, influenced coronation ceremonies after the birth of Christianity. According to a custom mentioned in the Bible, kings were anointed with *chrism*, a mixture of oil and balm. People thought that chrism gave the anointed ruler special miraculous powers. In England, popular belief held that a person who even touched the king's clothes could be cured of illness. In some coronation ceremonies, the ruler was ordained as one of the lower ranks of the clergy. The Holy Roman emperor became a subdeacon and canon of St. Peter's Church and St. John Lateran in Rome.

Related articles in World Book include:

Charlemagne (Military conquests)
Crown
Elizabeth II (picture)

Napoleon I (Crowned emperor)
Scone, Stone of Westminster Abbey

Coroner is the official who makes enquiries into any unnatural or sudden death of which the cause is un-



The coronation of Queen Elizabeth II took place in 1953. During the coronation, in Westminster Abbey, London, the monarch received crown, orb, sceptre, and other symbols of sovereignty. Some of the rituals of the coronation date from the Middle Ages.

known. There are coroners in, amongst other countries, Australia, Ireland, New Zealand, the United Kingdom (apart from Scotland), and the United States of America.

The coroner investigates how, when, and where the death occurred. He or she may hold an *inquest* (special court enquiry). A coroner *must* hold an inquest when there has been a violent or unnatural death. Coroners are also obliged by statute to hold an inquest in certain other cases, for example, in the United Kingdom, when a person dies in prison. A British coroner was formerly obliged to call a jury inquest when there was reason to suspect that the cause of death was murder, suicide, manslaughter, or infanticide, or if death resulted from a road accident. This obligation was abolished in 1977. Deaths may be reported to a coroner by a doctor, the police, or the public.

In the UK, when someone finds treasure, such as gold, silver, or precious stones, a coroner holds an inquest to decide whether it is treasure-trove.

In Australia, coroners have the power to hold an inquest into the causes or origins of fires that have damaged property. Also, in Queensland and South Australia they can hold an inquest concerning missing persons.

Coroners are normally appointed from senior lawyers or medical practitioners. Certain local authorities require that a coroner has both legal and medical qualifications. In the United States, coroners are usually elected in the same way as other local officials.

In Scotland, the office of coroner does not exist. The *procurator fiscal* enquires privately into sudden and suspicious deaths in his or her district.

The office of coroner originated in England and France. Early coroners guarded the fines collected by the king, or crown, and were called *crowners*. The word *coroner* comes from that title.

See also **Autopsy; Inquest; Jury; Procurator fiscal; Treasure-trove.**

Corot, Camille (1796-1875), was a French landscape and figure painter. His work formed an artistic bridge between the tradition of classical composition of the early 1800s and the romantic movement's concern with nature which led to impressionism.

Corot began to study painting against his parents' wishes. In 1825, he went to Italy, where he became concerned with the play of light and colour values. He began painting in solid masses in order to produce light and dark patterns of colour. Corot's early work shows the influence of the French landscape painters, Claude (Lorrain) and Nicolas Poussin, and of the Dutch landscape painters of the 1600s.

Corot returned to France in 1828 and travelled a great deal, because a small income left him free from economic worries. He came under the influence of a group of nature painters in the village of Barbizon. Corot was called 'the lyric poet' of this group. He changed his style, and began painting everything as if seen through a delicate grey veil, accented by a few details of bright colour. Corot's style underwent a final change in 1871. He again painted in the style of his youth, but his works were now drenched in impressionist light and colour. His painting, *A View near Volterra*, appears in the **Painting** article.

Corot painted portraits for his own pleasure throughout his career. He also painted religious pictures. His

portraits, along with his early and last paintings, are considered his best works. Corot was born Jean Baptiste Camille Corot in Paris.

Corporation is a person or group of people who obtain a charter giving them certain legal rights and privileges. A corporation can own property, buy and sell, manufacture products, and bring legal actions as if its members were one person. Business corporations are the most common type of corporation. Other types include municipal, government-owned, and quasi-public corporations. In the U.S.A., all companies which have been incorporated under U.S. law are known as corporations. Elsewhere in the world, the term corporation is used only to describe very large companies.

In the United States, state or federal government permission is required to form a corporation. State governments charter most corporations. National banks need federal approval. A corporation set up in one state can do business in other states if it files certain forms and pays required fees in those states. U.S. corporations are formed under *general incorporation laws*. People wishing to form a corporation file *Articles of Incorporation*, stating the purpose and makeup of the organization. Investors in a corporation have *limited liability*. If the corporation fails, they can lose no more than their investment, as the corporation's debts are not their debts.

Other corporations. Cities and towns may form *municipal corporations* to operate certain government enterprises, such as sewer, water, and school districts. Central or local governments may establish *government-owned corporations* to provide public facilities. One example is the British Broadcasting Corporation, which provides radio and television services.

Related articles in World Book include:

Bond	Company	Limited company
British Broadcasting Corporation	Conglomerate	Multinational corporation
Business	Franchise	Mutual company
Cartel	Holding company	Proxy
Charter	Joint-stock company	Stocks and shares

Corporation of the City of London. See **City of London**.

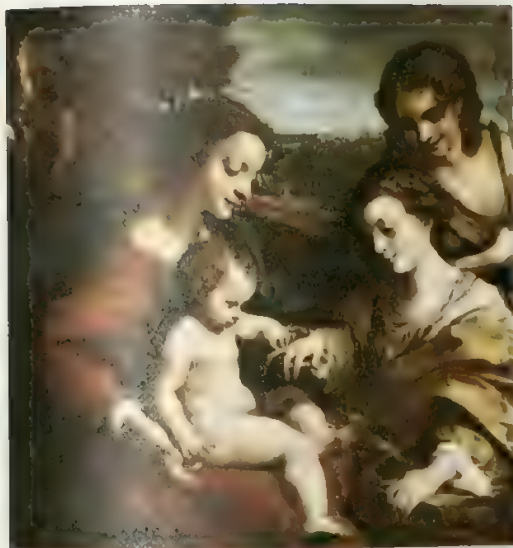
Corporative state. See **Fascism** (Economic life).

Corps is an army unit consisting of two or more divisions. The term *corps* comes from a Latin word meaning *body*. A corps is normally composed of about 65,000 to 90,000 soldiers, but the size can vary. Most corps are commanded by a lieutenant general. A corps can conduct major military operations. See also **Army**.

Corpuscle, in physiology, is a term used for a small mass or body. It is often used to mean *cell*, especially in referring to the red cells and white cells of the blood. Certain parts of the nervous system, such as the nerve endings in the skin that respond to pressure, are called *corpuscles*. See also **Blood**.

Corral. See **Ranching** (Life on a cattle ranch).

Correggio (1489?-1534) was one of the greatest painters of the Italian Renaissance. His most important works are *frescoes* (paintings on damp plaster) on two church domes in Parma, Italy. In these paintings, Correggio created the illusion that the ceilings open into the sky and many divine figures inhabit the clouds above the viewer's head. This dramatic illusion influenced the paintings of the baroque period of the late 1500s and the 1600s.



Oil painting of the late 1520s, The Louvre, Paris

Correggio's *The Mystic Marriage of Saint Catherine* shows the artist's soft treatment of flesh, his command of gentle light, and his delicate handling of shading. Correggio influenced painters of the baroque style in the 1600's.

Correggio's early paintings of religious and mythological subjects show a delicate, graceful style. Correggio worked chiefly in Parma, though his paintings suggest he may have visited Rome during the middle or late 1500's to become familiar with the paintings of Leonardo da Vinci and Raphael. Correggio's works show a more spirited emotional quality and dramatic handling of light than the work of those two masters.

Correggio's real name was Antonio Allegri. He took his name from the Italian town of his birth.

Corregidor, a rocky fortified island, covers about 5 square kilometres at the entrance to Manila Bay on the island of Luzon, in the Philippines. It is sometimes called the *Gibraltar of the Pacific*. The island has a population of about 320. During World War II (1939-1945), United States and Filipino troops made a determined stand on Corregidor against overwhelming Japanese forces. Their surrender on May 6, 1942, marked the end of organized U.S. resistance in the Philippines.

The Japanese held Corregidor until U.S. troops freed Luzon in February 1945. The United States ceded Corregidor to the Republic of the Philippines in 1947. In 1954, Corregidor became a Philippine national shrine dedicated to the American and Filipino troops who died there during World War II. The island has a war museum and a marble war memorial.

Correspondence school is an educational institution that teaches by means of an interchange of letters between teachers and pupils. Correspondence schools are intended for people who wish to study a subject systematically, generally for the purpose of acquiring professional or technical qualifications. Such people may be unable to attend classes in person because they are disabled, or because they live too far away, or because they are working during the day. By taking correspondence courses, students can do the work at any time and

in any place. But correspondence schools have the disadvantage that there is no personal contact between teachers and pupils.

In most countries, correspondence schools are organized privately. But in some countries, the state organizes correspondence schools and encourages adults to extend their education by this means. Correspondence schools are widely used in Africa, Australia, Latin America, and New Zealand.

The University Extension movement in England first used correspondence courses in 1868. The idea spread rapidly to many parts of the world. Correspondence courses began in Australia in 1910 and in New Zealand in 1922.

See also **Open University**.

Correspondent. See **War correspondent**.

Corrigan, Malread. See **Nobel Prizes** (table, Nobel Prizes for peace—1976).

Corroboree is a name used by white Australians to describe Aboriginal dances. The Aborigines themselves have different names for the dances performed in their camps, depending on different areas and languages. The camp dancing usually seen by white people and called *corroboree* by them is called *playabout dance* or *outside dance* by Aborigines to indicate that it is not one of their sacred dances. Family groups dance and sing for relaxation, and for the entertainment of the local group and other visitors. Their dances are of ancient origin and are passed on to children unchanged.

The Tiwi of Melville and Bathurst Islands, in the Northern Territory, improvise in camp dancing and in the mourning ceremony called *pukamani*. For example, an inspired mourner may suddenly make a song about the dead person, praising the person's virtues and feats. The Tiwi people also preserve in song and dance extraordinary events, such as the bombing of Darwin in World War II (1939-1945).

See also **Australian Aborigines**.

Corrosion is the destruction of a material caused by the chemical action of a gas or liquid. Corrosion occurs chiefly in metals, but it may also affect ceramics. Rust is



Corroborees are Aboriginal gatherings where songs and dances are performed for amusement, not for religious reasons.



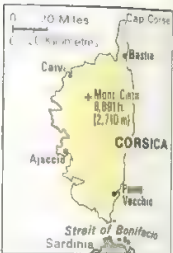
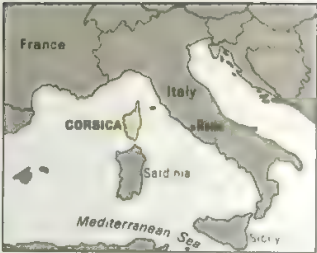
Uniform corrosion is a common type of corrosion that attacks large areas. It produces a greenish film known as *patina* when it occurs on such a surface as a copper roof, *above*.

the most familiar form of corrosion. This reddish-brown substance forms on iron and steel that are exposed to moist air or to water containing impurities. See **Rust**.

In most cases, corrosion involves two related chemical reactions—*oxidation* and *reduction*. In oxidation, the atoms of a metal give up electrons. In reduction, part of the same metal or an adjoining metal captures these electrons. The electrons that flow from one metal to the other form an electric current. In this sense, corrosion is an *electrochemical process* (see **Electrochemistry**).

There are many types of corrosion. One kind, called *localized attack*, occurs on small areas of bare metal and produces holes or cracks. Another type, *uniform corrosion*, attacks much larger areas, such as the surface of an aluminium pot or a copper roof. It can be beneficial. On copper roofs, for example, such corrosion produces a thin, greenish film called *patina* that protects the surface against further rapid corrosion.

The type of corrosion and its severity depend on the chemical makeup of the metal and of the corrosive



Corsica is a French island in the Mediterranean Sea.

agent. Other major factors include stresses in the metal, the temperature of the corrosive agent, and the speed at which the agent moves against the metal. Corrosion tends to be more severe if the corrosive agent hits the metal at a high speed. If the agent contains solid particles, the corrosion is even worse and is called *erosion-corrosion*.

See also **Oxidation; Reduction**.
Corrupt practices are unethical techniques used by politicians to gain a political advantage in an election. Many countries have legislation that governs campaigns and elections. These laws prohibit such activities as bribery, ballot-box stuffing, tampering with voting machines, and threatening or impersonating voters. Many of these laws also govern party campaign finances. For example, many countries have laws that limit the amount of money that can be spent by candidates and parties in national and local elections. See also **Election**.

Corsair. See **Pirate**.
Corsica (pop. 240,178) is a French island in the Mediterranean Sea. It lies 14 kilometres north of the island of Sardinia, between southeastern France and northwestern Italy. Corsica's name in French, the official language, is *Corse*. The island makes up two of the *departments* (main administrative districts) of France. It is the birthplace of Napoleon.



Corsica is a mountainous island with fertile valleys. Agriculture is the mainstay of the economy. Corsica's main exports include cheese, citrus fruit, olive oil, wine, and wool.

Size and description. Corsica has an area of 8,680 square kilometres. Its 443-kilometre coastline is high and craggy and has few natural harbours. The rocky interior is covered with scrub and cut by narrow, fertile valleys. Ajaccio, Corsica's capital and largest city, is on the western side of the island beside the Gulf of Ajaccio. Bastia, the second largest city, lies on the eastern side.

Economy. Corsica has a mild climate, and crops flourish in the rich soils of the valleys. Farmers raise olives, grapes and other fruits, grains, vegetables, and tobacco. Cork, pine, oak, and chestnut trees cling to the steep slopes of the mountains. Corsicans grind chestnuts into meal to make bread. Wool for clothing comes from sheep that graze in the mountains. Along the coast, the people fish for sardines and hunt for coral. Miners quarry granite and marble in the mountains. Some iron, lead, and copper are also mined.

Since World War II, the principal exports of Corsica have been wool and cheese. The island's fastest-growing source of income is the tourist trade. Tourists enjoy the climate, the rugged scenery, and the colourful villages of Corsica.

History. Corsica was first settled about 560 B.C. by Phoenicians, who called the island *Cyros*. It was conquered in turn by Etruscans, Carthaginians, and Romans. The Romans renamed the island Corsica. Vandals captured Corsica in A.D. 469, but the island was recaptured by Rome, under Justinian the Great, in 534. Later, Corsica was ruled by Charlemagne.

Pope Gregory VII assumed sovereignty of Corsica in 1077, and granted it to the Bishop of Pisa to control. About 300 years later, Corsica came under the control of the Italian city of Genoa. In 1768, the Genoese sold the island to the French, who lost it to the British in 1794. In 1796, Napoleon sent an expedition to Corsica to reestablish French control. France has held the island since then, except for a brief occupation by British soldiers in 1814, and the occupation by Italians and Germans during World War II. Allied forces freed the island in 1943, and it again became part of France.

During the 1970's, protests against French rule arose in Corsica. Since then, some Corsicans have called for independence from France. Others have favoured greater local control over the island's government. In 1982, the French Parliament created a Corsican regional assembly. Corsican voters elect the assembly, which controls local spending and the development of the island's economy, education, and culture.

Cortés, Hernando (1485-1547), was a Spanish adventurer who conquered what is now central and southern Mexico. His daring schemes to seize land, power, and wealth made him the greatest Spanish conqueror in the Americas. Cortés' military triumphs led to 300 years of Spanish domination of Mexico and Central America. His name is also spelled *Cortez*.

Early life. Cortés was



Hernando Cortés



Hernando Cortés sailed from Cuba to Mexico in 1519 and conquered the Aztec Indians there in 1521. He led an expedition to Honduras from 1524 to 1526 and one to Lower California in 1535.

born in the Spanish town of Medellín, in Castile. When he was 14 years old, his parents sent him to Salamanca, in west central Spain, to study law. But he soon left school to seek adventure and wealth.

In 1504, Cortés sailed to Hispaniola (now the Dominican Republic and Haiti) in the West Indies. In Hispaniola, he fought in several Indian battles and engaged in a number of commercial operations.

Cortés took part in the Spanish conquest of Cuba by Diego Velázquez in 1511. Velázquez, who became governor of Cuba, later learned of a rich Indian empire



Drawing with coloured ink on parchment by an unknown artist, Biblioteca Apostolica Vaticana (Vatican Library)

Hernando Cortés conquered Mexico for Spain in the early 1500's. The manuscript in picture writing, *above*, shows Cortés meeting the Aztec ruler Montezuma in 1519. An Aztec artist created the manuscript at Montezuma's request.

in Mexico. In 1518, Velázquez chose Cortés to lead an expedition there to seek gold, claim land, and develop trade with the Indians. After Cortés began to organize the expedition, Velázquez became suspicious of Cortés' ambition and removed him from command. Cortés ignored the governor's order and set sail for Mexico with about 600 Spaniards in February 1519.

Cortés' fleet of 11 ships landed near what is now Veracruz on the east coast of Mexico. The Spaniards soon learned that the Aztec Indians ruled an empire there and, in August 1519, began to march inland to Tenochtitlan (now Mexico City), the Aztec capital. Along the way, Cortés persuaded thousands of Indians to join his forces. Many Indians joined Cortés willingly because they hated the powerful Aztecs.

Conquest. Cortés and his army marched into Tenochtitlan in November 1519. The Aztec emperor, Montezuma, greeted him with gifts in a colourful ceremony. Many Indians believed that Cortés was Quetzalcoatl, the Aztecs' most honoured god. But Cortés soon imprisoned Montezuma and ruled the Aztec empire through him. The Spaniards seized large amounts of gold, destroyed a number of Aztec temples, and began to convert Indians to Christianity.

Several months after Cortés' conquest, Velázquez sent Spanish forces to arrest him for disobedience. Cortés and some of his men hurried to the coast to deal with them. Cortés persuaded Velázquez's troops to join his forces. But by the time Cortés returned to Tenochtitlan, the Aztecs had rebelled. After bloody fighting, they forced the Spaniards to retreat from the city in June 1520. Many of Cortés' men died in the battle, and most of the survivors were wounded.

Cortés then began to reorganize his forces and to obtain reinforcements from various Spanish settlements in the West Indies. In May 1521, Cortés' army of thousands of Indians and 1,000 Spaniards attacked Tenochtitlan. By August, his troops had destroyed the city and forced the Aztecs to surrender. Within a few months, Cortés controlled all central Mexico.

Later life. For several years, Cortés controlled much of present-day Mexico. He also explored Central America as far south as Honduras. In 1528, he sailed to Spain. The Spanish king, Charles I, gave him the title of *marquis* and the service of 23,000 Indians in Mexico. Cortés returned to Mexico in 1530 and engaged in exploring, farming, and mining. He travelled to Lower California in 1535. He became probably the wealthiest person in all Spanish America. He sailed back to Spain in 1540 and lived there for the rest of his life.

See also **Alvarado, Pedro de; Aztec (History); Cuauhtémoc; Mexico (The Spanish conquest); Montezuma.**

Cortex. See **Adrenal gland; Kidney; Root.**

Cortex, Cerebral. See **Brain (The cerebrum).**

Corticosteroid. See **Cortisone.**

Cortisone is one of an important group of hormones made in the *cortex* (outer part) of the adrenal glands. These compounds, called *corticosteroids*, are essential for life. They play an important part in regulating salt and sugar balances in the body. These compounds also help the body adjust to environmental changes and other kinds of stress.

Scientists synthetically produce cortisone and other

corticosteroids for use as drugs. Corticosteroids effectively reduce inflammation. Doctors use the drugs in treating arthritis, some kinds of cancer, disorders of the eyes and skin, and many other diseases. Patients who undergo a transplant operation may receive corticosteroids. The drugs lower the natural immune defences of the body and help it accept the transplanted organ. Doctors also prescribe corticosteroids for people whose adrenal glands produce too little of the natural compounds.

Cortisone and other corticosteroids can cause serious—even fatal—side effects and thus must be used carefully. The side effects include swelling of body tissues, changes in behaviour, ulcers, weakness of the bones and muscles, and an increased probability of developing infections. In addition, prolonged treatment with the drugs may cause the adrenal glands to temporarily stop producing natural corticosteroids. In such cases, withdrawal from the drugs must take place gradually to allow the glands to recover.

Biochemists isolated and determined the chemical structure of cortisone and many other corticosteroids during the 1930's and 1940's. In 1948, cortisone became the first of these compounds to be used as a drug to treat human patients.

Related articles in *World Book* include:

ACTH Gland Hormone

Corundum (chemical formula, Al_2O_3) is the second hardest pure mineral. Only diamond is harder. Corundum occurs as transparent nuggets in gravel, and as nontransparent grains in rocks.

Varieties of transparent corundum are polished and used as gemstones. Gemstones from corundum include the ruby, sapphire, Oriental amethyst, Oriental emerald, and Oriental topaz. The colours of the gemstones are caused by impurities in the corundum. For example, the red of the ruby is caused by the presence of traces of chromium, and the blue of the sapphire by iron and titanium. Gemstone corundum comes mainly from Australia, southeast Africa, Sri Lanka, and India.

Nontransparent corundum is used as an *abrasive* (grinding, smoothing, and polishing material). Emery, a common abrasive, is a natural mixture of corundum and other minerals. Abrasive quality corundum and emery are mined in Turkey and Greece.

Related articles in *World Book* include:

Amethyst Emery Hardness Sapphire
Emerald Gem Ruby Topaz

Corvette. See **Warship (Frigates).**

Coryphene. See **Dolphin.**

Cosby, Bill (1937-), is a leading American entertainer, author, and TV producer. He is noted for his warm, gentle humour, which centres on the family and the trials and troubles of childhood. His TV series, *The Cosby Show*, began in 1984 and quickly became the most watched TV show in the United States.



Bill Cosby

William Henry Cosby, Jr., was born in Philadelphia. He began his show business career as a comedian and has since recorded more than 20 comedy albums. He starred in several motion pictures, including *Hickey and Boggs* (1972) and *Uptown Saturday Night* (1974). Cosby was the first black performer to star in a TV dramatic series. This series, *I Spy*, originally ran from 1965 to 1968. Another success was his creation in 1972 of the TV cartoon series *Fat Albert* and *the Cosby Kids*, based on his most famous comic character.

Cosby is also an author. He has written *Fatherhood* (1986), a book of humorous essays; *Time Flies* (1987), a book about aging; and *Love and Marriage* (1989), which deals with romantic relationships.

Cosgrave, Liam (1920-), was *Taoiseach* (prime minister) of the Republic of Ireland from 1973 to 1977. He became leader of the Fine Gael Party in 1965 and for the following eight years was leader of the Opposition in Dáil Éireann (the House of Representatives of the Irish parliament). After winning a general election in 1973, he formed a government in coalition with the Irish Labour Party. His government lost the next general election in June 1977. Cosgrave then resigned as party leader. Cosgrave, the son of Irish political leader William Cosgrave, was born and educated in Dublin. He was first elected to the Dáil in 1943. From 1954 until 1957, he was minister for foreign affairs.

Cosgrave, William Thomas (1880-1965), was president of the Irish Free State's Executive Council from 1922 to 1932. He lost to Eamon De Valera's party, which wanted complete independence from England. Cosgrave criticized the 1937 Constitution, which established the republic of Éire. But he joined De Valera in supporting President Douglas Hyde's election in 1938.

Born in Dublin, Cosgrave went to prison for his part in the 1916 Easter Rebellion. Later, he served in the revolutionary government from 1919 to 1921. He became president after the deaths of two successive heads of the Irish Free State, Arthur Griffith and Michael Collins.

Cosimo de' Medici. See *Medici*.

Cosine. See *Trigonometry*.

Cosmetic surgery. See *Plastic surgery*.

Cosmetics are substances applied to a person's body to cleanse, promote attractiveness, or alter the appearance. Cosmetics include underarm deodorants, face powder, lipstick, nail polish, perfume, skin creams, most shampoos, and some toothpastes.

More than 5,000 ingredients are used in the manufacturing of cosmetics. These ingredients include alcohols, alkalis, detergents, dyes, glycerol, oils, talc, and waxes. A person who manufactures or sells cosmetics, or who applies them to others, is called a *cosmetician*. The study of cosmetics and their uses is called *cosmetology*.

Kinds of cosmetics. Most cosmetics can be classified into four main groups, according to the part of the body for which they are used: (1) skin, (2) hair, (3) nails, and (4) mouth.

Skin cosmetics include such makeup as blushers, rouge, face powder, foundations, and lipstick. Also in this group are eyeliners, eye shadow, and mascara, as well as bubble baths, cold cream, underarm deodorants, foot powder, hair-removal substances, perfume, shaving cream, moisturizers, and suntan lotion.

Hair cosmetics include hair conditioners, mousses,

sprays, styling lotions, straighteners, and permanent waves. Such hair-colouring products as dyes and bleaches are also hair cosmetics, as are shampoos that do not contain antidandruff ingredients.

Nail cosmetics. Nail polish and cuticle softeners are the chief products in this group.

Mouth cosmetics, also called *oral cosmetics*, include toothpastes and other substances that clean the teeth and gums but do not have cavity-fighting ingredients. Mouthwashes and sprays are also oral cosmetics.

Other cosmetics. Performers in motion pictures, television, theatre, and circuses wear special cosmetics that must withstand the heat from powerful lights without melting or running. They also must be visible to the audience. Many people use special medicinal cosmetics to conceal birthmarks, scars, or other skin blemishes.

Cosmetics regulations. Many governments require that cosmetics be safe and properly labeled. They test products to determine if unsafe ingredients are present and they inspect cosmetics factories. Some regulations require cosmetics manufacturers to list on each package the names of the ingredients used in the product, in order of descending concentration.

History. Men and women have used cosmetics for thousands of years. The ancient Egyptians applied perfumes and anointing oils to the body as early as 4000 B.C. They used these cosmetics for decoration, for protection against the hot, dry climate, and for religious reasons. The Egyptians, Greeks, and Romans made cosmetics from plants. They also used powdered minerals to make face and eye makeup and hair dyes.

By the A.D. 1100's, the use of cosmetics had spread to Western Europe. Africans of about the same period painted their bodies for war and for magical ceremonies. In North America, the first cosmetics were animal fats used by Indians long before Europeans arrived. The Indians applied these substances as a base for body paint and as protection against insects and the cold.



Cosmetics worn by stage performers must be visible to the audience. Actors in Beijing, China, apply bold eye makeup.

By the early 1900's, most people used only such basic cosmetics as face powder, rouge, and shampoos. Demand for a wider variety of cosmetics grew tremendously after the 1930's, as did widespread advertising and promotion of these products.

Cosmic rays are high-energy particles that originate in outer space. Scientists believe these rays fill the Milky Way and other galaxies as well. Cosmic rays consist of subatomic particles that carry an electric charge, such as protons, electrons, and the nuclei of atoms. In outer space, they travel at nearly the speed of light, which is 299,792 kilometres per second.

Physicists measure the energy of cosmic rays in units called *electronvolts* (eV). Most cosmic rays have energies that range from a few million electronvolts (MeV) to a few billion electronvolts (GeV). A billion electronvolts would light a torch bulb for only about one ten-billionth of a second. However, when a cosmic ray proton carries that amount of energy, it can travel through an iron plate nearly 60 centimetres thick.

Cosmic rays originate from many sources in space. Scientists believe that exploding stars called *supernovae* and very dense stars known as *pulsars* produce great quantities of cosmic rays. Some cosmic rays come from the sun.

Only cosmic rays with very high energies can penetrate the earth's atmosphere. Fewer than one in a million of those reach the earth's surface without colliding with an atom in the air. These collisions destroy both the cosmic ray and the atom, producing showers of high-energy subatomic particles. Some of these particles do reach the surface and even penetrate deep underground. The cosmic rays in outer space are called *primary cosmic rays*. The showers produced in the atmosphere are *secondary cosmic rays*.

Scientists study cosmic rays because these particles provide samples of matter that has travelled through millions of *light-years* of space. A light-year is the distance light travels in one year—about 9.46 trillion kilometres. Cosmic-ray research has enabled scientists to learn much about the physical conditions in regions far from the solar system.

Primary cosmic rays

Primary cosmic rays, also called *primaries*, are cosmic-ray particles that originate in space. There are two main types of primaries—*galactic* and *solar*.

Galactic cosmic rays come from outside the solar system. They make up most of the primaries. During periods of low activity on the sun, on average one galactic cosmic ray strikes each square centimetre of the top of the atmosphere each second.

About 98 per cent of galactic cosmic rays are atomic nuclei. The other 2 per cent consist of electrons and *positrons* (electrons with a positive charge). Of the nuclei, about 87 per cent are *protons* (hydrogen nuclei) and 12 per cent are helium nuclei. The rest of the nuclei include those of all the elements heavier than helium.

Physicists believe that most galactic cosmic rays are accelerated to their high energies by shock waves from supernovae or by strong magnetic fields around pulsars. Galactic cosmic rays can also gain energy from collisions with moving kinks in the weak magnetic fields in *interstellar space* (space between the stars). A magnetic

field can be thought of as a set of imaginary lines of magnetic force extending through space. Like beads on a string, the particles move easily along these *field lines* but have difficulty cutting across the lines. When a field line moves, some of the energy of its motion is transferred to the particles travelling along it.

Once accelerated, the galactic cosmic rays in the earth's galaxy travel randomly in the galaxy's magnetic fields for an average of about 10 million years. They eventually either escape from the galaxy or are slowed down by collisions with interstellar matter.

Some galactic cosmic rays are kept out of the solar system by the *solar wind*. The solar wind consists of electrically charged atoms that flow outward from the sun throughout the solar system. The solar wind carries a magnetic field, which excludes many galactic cosmic rays from the solar system, especially during periods of high activity on the sun's surface. Thus, the concentration of galactic cosmic rays near the earth decreases as solar activity increases in an 11-year cycle called the *sunspot cycle* (see *Sunspot*).

Solar cosmic rays are produced by the sun during *solar flares*. Solar flares are spectacular eruptions at the sun's surface that occur mainly during periods of high activity in the sunspot cycle. The particles released in these flares typically have energies of only a few MeV, but particles with energies of up to a few GeV may be produced in large flares. Most solar cosmic rays are protons. Others consist of heavier nuclei or electrons. (See *Van Allen belts*.)

Other high-energy particles in space. Some particles are accelerated to energies of many MeV in the earth's *magnetosphere*. A magnetosphere is the region of space filled by a planet's magnetic field. Jupiter, Saturn, Uranus, and Neptune also have magnetospheres in which particles are accelerated to energies of many MeV. Most particles stay trapped in the magnetospheres and form belts of radiation around the planets.

In addition, particles are accelerated to energies of a few MeV by shock waves in the solar wind. These shock waves are produced by solar flares or by fast streams in the solar wind that behave like gusts or jets.

Secondary cosmic rays

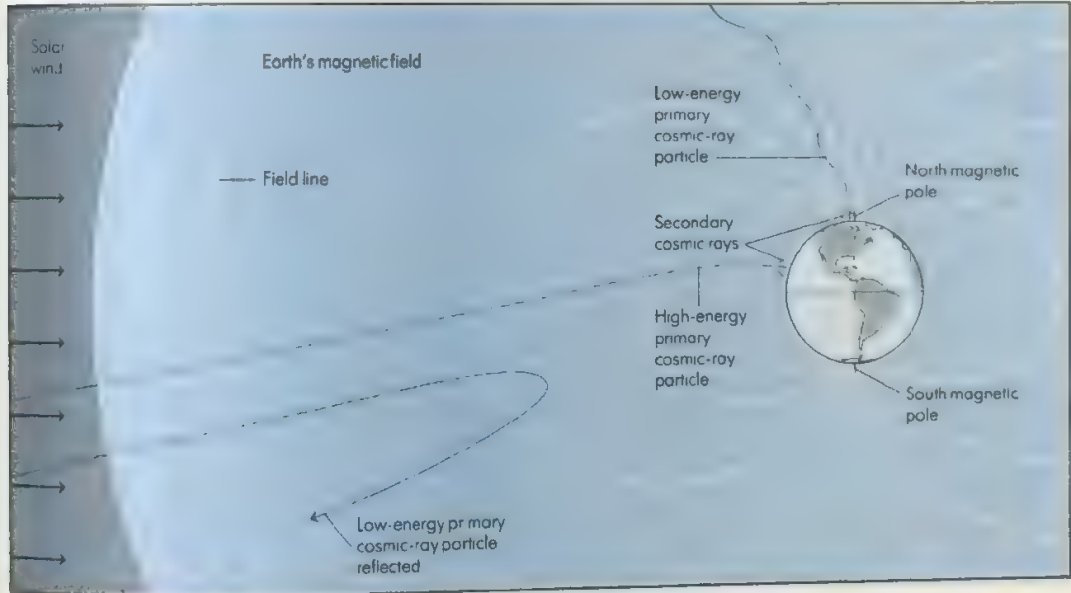
Secondary cosmic rays, or *secondaries*, are produced when primary cosmic rays collide with atomic nuclei high in the earth's atmosphere. In these collisions, the primaries break up, and some of their energy takes the form of subatomic particles. A number of the new particles collide with other nuclei in the atmosphere, producing even more particles. Such successive collisions produce a shower of secondaries that includes all types of subatomic particles. Secondary cosmic rays occur from the upper atmosphere to the deepest mines in the earth.

Secondaries slow down in the atmosphere, and so only a small fraction of them reach the earth. Every minute, on average one particle strikes each square centimetre of the earth's surface. Most of these particles are subatomic particles called *muons*.

The concentration of secondaries in the atmosphere is affected by the earth's magnetic field. The lines of this field curve from the earth's north magnetic pole to the south magnetic pole. Only primaries with extremely

How cosmic rays penetrate the earth's magnetic field

Primary cosmic-ray particles, even those with low energies, can enter the earth's atmosphere near the poles by travelling along the field lines of the magnetic field. Only particles with extremely high energies can cut across the field lines and reach the atmosphere near the equator. The magnetic field there reflects most particles, including many with high energies. Secondary cosmic rays are created in the atmosphere by collisions between the primary rays and atomic nuclei.



high energies can penetrate the magnetic field near the equator because they must cut across the field lines. Near the poles, even primaries with low energies can travel along the field lines and strike the atmosphere. Thus, the concentration of secondaries is lowest at the equator and increases toward the poles.

Effects of cosmic rays

The level of radiation produced on the earth by cosmic rays is far too low to harm living things. Scientists measure radiation dosage in units called *rads*. Long-term dosage of more than a few rads a year is considered unsafe. At sea level, the dose from secondary cosmic rays is less than 0.04 rad per year. Even beyond the atmosphere, the dose from galactic cosmic rays is less than 10 rads per year. However, the level of radiation in the earth's radiation belts can endanger astronauts and damage instruments, as can radiation anywhere above the atmosphere after large solar flares. As a result, spacecraft that may encounter such radiation must carry shielding against it. Manned space missions try to avoid the radiation belts and large solar-flare events.

Problems have resulted on some spacecraft from the effects of galactic cosmic rays on the crafts' electronic circuits. A single cosmic ray that penetrates a tiny circuit chip can change the information stored on the chip. The high energy of galactic cosmic rays makes it almost impossible to shield against them. Therefore, scientists and engineers have had to develop circuit components that are less sensitive to cosmic-ray effects.

One useful effect of cosmic rays comes from a reaction of secondaries with nitrogen nuclei in the earth's atmosphere. This reaction produces a radioactive form of carbon, called *radiocarbon*. Living things continuously

incorporate carbon—including radiocarbon—into their cells. Because radiocarbon breaks down at a constant rate, the amount of it left in once-living material can tell scientists the material's age (see *Radiocarbon*).

Cosmic-ray research

Early studies. During the late 1800's, physicists used instruments called *electroscopes* in the study of radioactivity. Even when shielded from the most powerful radioactive rays, the instruments continued to react as if an unknown form of penetrating radiation were present. In 1912, the Austrian physicist Victor Hess took electroscopes along on a balloon flight. They indicated that radiation increases with altitude, and so Hess concluded that the radiation must originate in the atmosphere or beyond. In 1936, Hess received the Nobel Prize for physics for discovering cosmic rays.

Physicists originally thought that cosmic rays were gamma rays (see *Gamma rays*). In the late 1920's, scientists discovered that cosmic rays, unlike gamma rays, are affected by magnetic fields. This effect indicated that the rays must be charged particles. In the late 1940's, the photographic study of cosmic rays revealed that primaries consist mainly of hydrogen nuclei and helium nuclei. In the 1950's, physicists studied the effects of the sun on cosmic rays. In 1961, they first observed electrons among primaries. Since the 1960's, spacecraft have enabled scientists to study primaries outside the earth's atmosphere and magnetic field.

Research today. Much cosmic-ray research today involves the physical nature of the stars and other objects that make up galaxies. If, as scientists believe, cosmic rays are accelerated by supernovae and pulsars, the particles provide samples of matter from places near these

objects. Studying such cosmic rays helps scientists learn about the nuclear processes that occur when a star explodes as a supernova and about conditions near a pulsar. Cosmic-ray research also uncovers clues about the structure and distribution of the matter and magnetic fields that primaries encounter in interstellar space.

New instruments are being designed that will provide more detailed information about the origin, acceleration, and travel of the most energetic cosmic rays. These devices also will permit closer examination of the nuclear composition of lower-energy primaries.

Secondary cosmic rays were once the main source of subatomic particles used in research. From the 1930's to the 1950's, physicists discovered many new subatomic particles among secondaries. Today, physicists use machines called *particle accelerators* for most particle research. However, the study of cosmic rays may reveal new kinds of subatomic particles that exist only at energies much higher than accelerators can produce.

See also **Radiocarbon**.

Cosmology, in astronomy and astrophysics, is the study of the structure, dynamics, and development of the universe. It tries to explain how the universe was formed, what happened to it in the past, and what might happen to it in the future.

Astronomers interpreted three chief observations of the universe to develop the theories that make up modern physical cosmology. They noted that the sky's being dark at night contradicted a simple explanation of the universe. Astronomers also observed that distant galaxies move away from one another, and that the entire sky gives off radio waves.

During the 1700's and 1800's, several astronomers thought about the sky's being dark at night. In the simplest universe they could imagine, the universe extended forever with stars distributed evenly throughout it. But in such a universe, a person would be able to look anywhere in the sky, and the person's line of sight would eventually reach a star. The entire night sky would therefore appear to be a solid mass of stars as bright as the sun. But the sky is dark—and so astronomers deduced that the universe must have a more complex structure.

In the early 1900's, astronomers observed that the light from stars in distant galaxies was shifted toward the longer, or red, wavelengths of the *spectrum* (colour pattern). This phenomenon, called *red shift*, is interpreted as resulting from the rapid motion of the galaxies away from one another. Astronomers can calculate the speed of a galaxy from its red shift (see **Red shift**). By studying the speed of the galaxies' motion at various distances from the earth, they found that all galaxies began moving away from one another 10 billion to 20 billion years ago.

In 1965, astronomers detected faint radio waves regardless of where they pointed their radio telescopes. This observation showed that the entire universe is a source of weak radio waves. It also reinforced the idea that the universe is expanding because the faint radio waves are similar to those that would be emitted by an extremely hot object that is still expanding in all directions.

The **big bang theory** provides the best explanation of the three basic cosmological observations. According

to this theory, the universe began as the result of an explosion—called the big bang—10 billion to 20 billion years ago. Immediately after the explosion, the universe consisted chiefly of strong radiation. This radiation formed a rapidly expanding region called the *primordial fireball*.

After this fireball had cooled down, the main part of the fireball was matter, chiefly in the form of hydrogen. It also included a small amount of helium and other light elements. Today, faint radio waves are all that remain of the radiation from the original fireball. The matter continued to decrease in density after the explosion. In time, the matter broke apart in huge clumps. The clumps became galaxies. Smaller clumps within the galaxies formed stars. Part of at least one clump became a group of planets—the solar system.

The galaxies are still moving away from one another, and the best current evidence indicates that they will move apart forever. But astronomers do not rule out the possibility that all the galaxies will come together again in about 70 billion years. If this happens, all the material in the universe will explode again in another big bang, resulting in a new phase of the universe resembling the present one.

The **steady state theory** offers another explanation of cosmological observations. According to this theory, the universe has always existed in its present state. As the galaxies move apart, new matter appears between them and forms new galaxies. However, the theory does not say where this matter comes from. Today's astronomical observations do not support the steady state theory.

See also **Universe** (Cosmological theories).

Cosmology. See **Philosophy** (Metaphysics).

Cosmonaut. See **Astronaut**.

Cosmos are tall, late-summer flowers native to Mexico and the American tropics. Their flowers range from white and pink to red and orange, and may be double or single. Seeds may be planted outdoors after the ground warms, or they may be planted indoors in early spring and then transplanted a few weeks before summer. Cosmos are well adapted to full sun, and to light soil that is not too rich. Most varieties need protection from wind because they are so tall. They make good background plants or fillers among shrubs. Cosmos also provide excellent cut flowers.

Scientific classification. Cosmos belong to the daisy family, Compositae (Asteraceae). They make up the genus *Cosmos*. The familiar garden plants are *C. bipinnatus*, the yellow cosmos is *C. sulphureus*.

See also **Flower** (picture: Garden annuals).

Cosmos, in physics and astronomy, is a term used to refer to everything that exists, from the smallest atoms to the most distant celestial bodies. It comes from the ancient Greek word *kosmos*, which means order, the universe, or the world.

To the ancient Greeks, the cosmos was a well-ordered, harmonious system consisting of the earth, the sun, the stars, the moon, and the visible planets. Today, we know that the sun is only one of about 100 billion stars that form the Milky Way galaxy. This galaxy is one of at least 100 billion galaxies that make up the observable universe.

See also **Cosmology**; **Galaxy**; **Universe**.

Cossacks were originally peasant soldiers who lived in the frontier areas of the Russian Empire. Most of them lived in an area that is now Ukraine. Beginning in the 1400s, Poland and Russia organized the Cossacks into military units to help fight Tartar invaders. Both Poland and Russia granted the Cossacks many privileges as a reward for their services. The Cossacks formed self-governing communities that were based on democratic principles. The word *Cossack* means *free person* in Turkic.

During the 1500's and 1600's, Poland and Russia tried to abolish the Cossack privileges, and the Cossacks often revolted. During the 1800's, some Cossack groups formed special units in the Russian Army.

In 1917, the Bolshevik Revolution led to the establishment of a Communist government in Russia. The revolution started a civil war, in which many Cossacks fought the Communists. The Communists broke up Cossack communities after winning the war in 1920.

See also Ukraine (History).

Cost. See Price.

Cost-benefit analysis, also called *benefit-cost analysis*, is a type of economic study that measures the costs and benefits to society of existing projects or plans that have been proposed. Government and industry planners use cost-benefit analyses to help them make decisions.

Cost-benefit analysts focus on a clearly stated proposal, such as plans to create a park or to extend a road system. They try to determine the social effects of the proposal on as large a number of people as possible. Analysts formulate their estimates of costs and benefits in financial terms. If the project produces economic benefits that exceed the cost of putting it into action, the project is judged to be worthwhile. Projects that produce this kind of economic benefit are called *cost-effective*.

Stating social costs and benefits in monetary terms poses a problem for analysts. Some factors, such as labour and materials, have measurable market prices. But other factors, such as the loss or creation of a beautiful area or an improvement in safety standards, are difficult to value in money terms. Cost-benefit analysts therefore must estimate a value called a *shadow price* for these factors.

Analysts also have the problem of studying policies that affect people for many years. A delay in receiving something generally lowers its current value. Analysts calculate this lower value through a procedure called *discounting*. Analysts often assess projects by calculating the ratio between the discounted value of benefits and the discounted value of costs. If this ratio is greater than one, the project is considered to be economically worthwhile.

Cost of living is the amount of money needed to buy a standard amount of consumer goods and services. Needs of individual persons and families vary. Everyone needs food, clothing, and shelter, but wants go beyond these bare necessities. The cost of living may include the cost of transportation, reading, recreation, rent, electricity, gas, fuel, home furnishings, medical and personal care, taxes, and many other things.

When salaries and wages rise at the same rate as the prices of consumer goods and services, the worker's buying power remains stable. When prices rise, people

Changes in the cost of living in the 1900's

The Consumer Price Index measures the cost of living in the United States. The index is prepared by the U.S. Bureau of Labor Statistics, which collects prices for thousands of goods and services. The graph shows a sharp rise in the cost of living in the 1970's and 1980's.



Year	Index	Year	Index
1915	10.1	1960	29.6
1920	20.0	1965	31.5
1925	17.5	1970	38.8
1930	16.7	1975	53.8
1935	13.7	1980	82.4
1940	14.0	1985	107.6
1945	18.0	1986	109.6
1950	24.1	1988	118.3
1955	26.8	1990	130.7

Source: U.S. Bureau of Labor Statistics.

with fixed incomes, such as pensions, fall behind in buying power. Changes in the cost of living have many causes. For example, when the buying of consumer goods increases faster than the nation's ability to produce them, prices tend to go up. But when more goods than money are available, prices go down.

Most governments have a ministry and statistical department responsible for the collection and analysis of data on employment, wages, and productivity. It will also collect data to measure changes in the prices of consumer goods and services, and report its findings through publications. It publishes a Consumer Price Index that summarizes this information. Preparation of this index involves the regular collection of information on prices and costs from thousands of food stores, homeowners and tenants, and other sources.

A system called *indexing* or *indexation* is being increasingly used to tie prices, wages, and taxes to the rate of inflation. Indexing provides for automatic increases and decreases in prices, wages, and taxes as the official cost-of-living index rises and falls. For example, some contracts of employment have an *escalator clause*, which automatically lifts wages as the cost of living increases.

See also Consumer Price Index; Inflation.



San José, Costa Rica's capital and largest city, lies in a valley in the mountainous interior. Modern shops and office buildings stand among Spanish-style churches and houses.

Costa Rica

Costa Rica is a small, mountainous country in Central America. It is bordered by Nicaragua on the north, the Caribbean Sea and Panama on the east, and the Pacific Ocean on the south and west. A chain of rugged mountains stretches across central Costa Rica from northwest to southeast. A few of the highest peaks in this chain are active volcanoes. Tropical forests grow on the country's coastal lowlands.

Only El Salvador, of all the Central American republics, is smaller in area than Costa Rica, and only Panama has fewer inhabitants. But Costa Rica's population is growing faster than that of any other country in Central America.

Spanish explorers arrived in what is now Costa Rica in the early 1500's. The people who lived there told them stories about deposits of gold and other precious metals supposedly mined in the region. The Spaniards named the land *Costa Rica*, which means *rich coast*. But the explorers found that the area had little mineral wealth.

Today, almost all Costa Ricans are of mixed Spanish and indigenous ancestry. About three-quarters of the people live on a fertile plateau in the mountains of central Costa Rica. San José, the capital and largest city, lies in this region. Hillsides covered with coffee trees surround San José. Coffee ranks as the country's chief export. Bananas, another major export, grow on large plantations near the coasts.

Government

Costa Rica is a democratic republic. Its Constitution was adopted in 1949. A president serves as the nation's chief executive and head of state. The people elect the president to a four-year term. The president and the

members of the Cabinet make up the Council of Government. The council conducts foreign affairs and enforces national laws. It may also veto bills passed by the Legislative Assembly, Costa Rica's legislature.

The Legislative Assembly has 57 deputies elected by the people to four-year terms. Neither the president nor the deputies may be elected to two terms in a row. The Supreme Court of Justice, the nation's highest court, has 17 justices appointed by the legislature. The army was abolished in 1948, but military forces may be organized for national defence if necessary.

Costa Rica has seven provinces. The provinces are divided into 80 *cantons* (counties). Each province has a governor who is appointed by the president. A council

Facts in brief about Costa Rica

Capital: San José.

Official language: Spanish.

Official name: República de Costa Rica (Republic of Costa Rica).
Area: 51,100 km². *Greatest distances*—north-south, 354 km; east-west, 381 km. *Coastline*—612 km on the Pacific; 214 km on the Caribbean.

Elevation: *Highest*—Chirripó Grande, 3,819 m above sea level. *Lowest*—sea level along the coasts.

Population: *Estimated 1996 population*—3,495,000; density, 65 people per km²; distribution, 47 per cent urban, 53 per cent rural. *1984 census*—2,416,809. *Estimated 2001 population*—3,868,000.

Chief products: *Agriculture*—bananas, beef cattle, cacao, coffee, maize, rice, sugar cane. *Manufacturing*—cement, clothing, furniture, machinery, processed foods, textiles.

National anthem: "Noble Patria, Tu Hermosa Bandera" ("Noble Homeland, Your Beautiful Flag").

Money: *Currency unit*—colon. One colon = 100 céntimos.

ected by the people governs each canton. The cantons provide fire protection, sanitation, water, and other local services.

All citizens 18 years or older are required to vote in national elections. The country has two major political parties, the National Liberation Party and the Social Christian Unity Party. The country also has several minor parties.

People

Population and ancestry. For Costa Rica's total population, see the *Facts in brief* table with this article. About half the people live in cities. San José is the capital and largest city.

Many Spanish colonists who settled in Costa Rica in the 1500's and 1600's married native inhabitants. Their descendants are called *mestizos*. Today, mestizos and whites of unmixed ancestry make up more than 97 per cent of the population. Costa Rica also has two small minority groups—about 70,000 blacks and about 10,000 "Indians" (descendants of the country's original inhabitants). The blacks live along the Caribbean coast. Their ancestors came to Costa Rica from the island of Jamaica in the late 1800's to build railways and to work on the banana plantations. The Indians live in isolated communities in the highlands and along the Caribbean and Pacific shores. They keep their tribes' traditional ways of life.

Costa Ricans take great pride in their country's heritage of democratic government and social equality. They also value their own personal dignity and strong family ties. Nearly all Costa Ricans speak Spanish, but many blacks still speak a Jamaican *dialect* (local form) of English. About 90 per cent of the people belong to the Roman Catholic Church.

Housing. About half of all Costa Ricans live on farms or in rural towns. Many farmers live in adobe cottages with thick, white stucco walls and red- or pink-tiled roofs. Other farmers live in brightly painted wooden houses. Most city people live in *terraced houses*. These look much alike and are attached to one another in a row. Many Costa Ricans decorate their homes with plants and flowers. Wealthy families own spacious



An open-air market in Cartago is packed on Sundays with shoppers who buy produce from farmers. The woman in the foreground is selling tickets for Costa Rica's national lottery.

ranch-style or Spanish-style homes surrounded by gardens.

Food. The diet of most Costa Ricans includes beans, coffee, maize, eggs, rice, vegetable marrow, and such tropical fruit as bananas, guavas, mangoes, oranges, and pineapples. Most families also serve beef, fish, poultry, and many kinds of soups. They often prepare *tamales* (ground pork and cornmeal steamed in banana leaves) and *tortillas* (thin flat bread made from maize or wheat flour).

Education. About 93 per cent of Costa Rica's people can read and write, a higher percentage than in any other Central American country. Costa Rican law requires all children to go to primary school. Successful students may attend secondary school and then enter a university. The country has several universities, including the National University in Heredia and the University of Costa Rica near San José.

Recreation. Costa Ricans enjoy spending their leisure time outdoors. Many of them play soccer, the national sport, on local sportsgrounds. Basketball, tennis, and swimming are also popular. Many Costa Ricans take



Costa Rica is a Central American country that lies between the Caribbean Sea and the North Pacific Ocean.



Costa Rica's state flag, used by the government, was adopted in 1848. The national flag has no coat of arms.



The coat of arms shows volcanoes, the Caribbean Sea, and the Pacific Ocean. Each star represents a province.



Provinces*			Ciudad			Ciudad			Ciudad		
Alajuela	427,962	A 3	Quesada	13,885	B 3	Miramar	2,137	B 3	San Juan*	22,415	B 3
Cartago	271,671	B 4	Corredor	13,846	D 5	Naranjo*	7,772	B 3	San	11,400	B 4
Guanacaste	195,208	B 1	Curridabat*	17,046	B 3	Nicoya	9,226	B 2	Nicolas*	24,519	B 4
Heredia	197,575	B 3	Desamparados*	43,352	B 3	Orosi	4,577	B 3	San Pedro*	3,689	A 1
Limón	168,076	B 4	Escazú	10,085	B 3	Palmar Sur	14,845	C 4	San Rafael	9,624	B 4
Puntarenas	265,823	D 4	Filadelfia	3,908	B 2	Pacamera	4,727	B 2	San Ramón	9,624	B 4
San José	890,434	B 3	Golfo	8,663	D 4	Paraiso	1,322	B 2	San	23,675	B 4
			Grecia	10,350	B 3	Parrita	1,728	C 3	Vicente*	7,848	B 4
			Guadalupe	25,506	B 3	Puerto	2,579	C 4	Santa Cruz	2,659	B 4
			Guápiles	6,189	B 4	Cortés	2,721	D 4	Santiago	3,372	B 4
			Heredia	21,440	B 3	Jiménez	2,721	D 4	Santo	5,032	B 4
			La Cruz	2,593	A 2	Puntarenas	28,640	B 2	Domingo*	2,466	C 3
			La Cuesta	9,449	D 5	Quepos	2,910	C 4	Savegre	9,812	B 4
			La Fortuna	4,476	B 3	Roxana	5,824	B 4	Siquirres	4,682	B 4
			Las Juntas	6,568	B 2	Sabalito	9,063	C 3	Tilarán	16,831	B 4
			Lepanto	9,064	B 2	Sánara	1,979	B 2	Turrialba	7,008	A 4
			Liberia	15,993	A 2	San Antonio*	7,143	B 3	Upala	1,689	B 4
			Limón	42,082	B 3	San Ignacio	856	B 3	Veintisiete	6,890	B 4
			Los Chiles	5,154	A 4	San Isidro	8,761	C 4	de Abril	3,589	C 4
			Matina	1,031	B 4	San José	241,464	B 3	Volcán	1,611	B 4
							360,000	B 3	Zarcero	1,611	B 4

*Does not appear on the map; key shows general location.
*Population of metropolitan area, including suburbs.
Source 1984 census.

part in colourful festivals on religious holidays. Bull-fights, fireworks, and masked parades attract thousands of Costa Ricans and foreign tourists to San José during the Christmas festivals.

Many Costa Ricans and tourists from other countries enjoy visiting Costa Rica's national parks. The national park system includes sandy beaches where sea turtles come to lay their eggs, tropical rain forests that are the homes of monkeys and colourful birds, and several active volcanoes.

The land and climate

A chain of high mountain ranges, which are called *cordilleras*, crosses central Costa Rica from northwest to southeast. The cordilleras divide the country into three land regions: (1) the Central Highlands; (2) the Caribbean Lowlands; and (3) the Pacific Coastal Strip.

The Central Highlands consist of two large areas of fertile farmland—the *Meseta Central* (Central Plateau) and the *Valle del General* (Valley of the General). The steep cordilleras surround each area. The Meseta Central is the country's heartland. About 75 per cent of the people live there. The Meseta's rich volcanic soil and favourable climate also make it the country's chief coffee-growing region. Daytime temperatures range from 24° to 27° C all the year round. The area receives about 180 centimetres of rainfall a year. The Valle del General lies to the southeast. It is an agricultural region of hills and plains. Daytime temperatures range from 27° to 32° C. Yearly rainfall averages about 280 centimetres.

The Caribbean Lowlands, a wide band of swampy tropical jungles, lie along the east coast. The daytime high temperature averages about 38° C. Yearly rainfall ranges from 380 to 510 centimetres.

The **Pacific Coastal Strip** is largely an area of low-lands along the west coast. Low mountains rise along most of the shore. This region has an ideal climate for growing bananas. Daytime temperatures range from 25° to 38° C. Total annual rainfall is about 330 centimetres.

Economy

Costa Rica's most valuable natural resource is its fertile volcanic soil. Forests of oaks, pines, and such tropical hardwoods as cedrelas and mahoganies cover about a third of the land. However, *deforestation* (destruction of forests) is a problem. Costa Rica also has small deposits of bauxite and manganese.

About a quarter of Costa Rica's workers are engaged in farming or ranching. Bananas, beef cattle, *cacao* (seeds used to make chocolate), coffee, maize, rice, and sugar cane rank as the chief agricultural products. Farmers also grow cut flowers; and oranges, beans, potatoes, and other fruit and vegetables. Manufacturing employs about a fifth of the labour force and is growing rapidly. The leading manufactured products include cement, clothing, cosmetics, fertilizer, furniture, machinery, medicines, processed foods, and textiles.

Costa Rica's economy depends heavily on foreign trade. Its leading exports include bananas, beef, coffee, and sugar. Its chief imports include petroleum, chemicals, and manufactured goods. The United States and Germany are Costa Rica's major trading partners. Costa Rica belongs to the Central American Common Market, an economic union that was formed to stimulate trade among its members.

The Pan American Highway links all of Costa Rica's provincial capitals except Limón (see **Pan American Highway**). Railways connect the port cities of Limón and Puntarenas to San José. Costa Rica has an average of 1 car for every 27 people. Costa Rican Airlines has flights from San José to other Central American cities and to Mexico and the United States.

Most Costa Rican families own a radio. The country



Costa Rica has three land regions. Most people live in the Central Highlands, where the temperatures are more comfortable than in the Caribbean Lowlands and the Pacific Coastal Strip.

has about one television set for every six people. Costa Rica's four daily newspapers are all published in San José.

History

Little is known about the earliest inhabitants of Costa Rica. But by A.D. 1000, the Corobici tribe had settled in the northern valleys, and the Boruca had migrated to lands in the south. The Carib, Chorotega, and Nahau arrived in the 1400's. Most of these groups survived by growing crops and hunting small game.

Colonial period. Christopher Columbus arrived in Costa Rica in 1502. Rumours of gold deposits in the area soon lured hundreds of Spaniards to the new land. The



The Central Plateau is the agricultural heartland of Costa Rica. Coffee, maize, rice, and sugar grow on the rolling hillsides. The city of San José lies in the distance.



Coffee beans drying in the sun are raked by workers at a *beneficio* (processing plant) in the Central Plateau. Coffee ranks as Costa Rica's chief export.

Spaniards found little mineral wealth. But many of them stayed to become farmers in the Central Highlands. Governor Juan Vázquez de Coronado founded the first permanent settlement at Cartago in 1564. Many Spaniards tried to enslave the Indians, but most of the tribes fought fiercely to stay free.

Independence. Costa Rica remained a Spanish colony until 1821. That year, Costa Rica and Spain's other Central American colonies broke away from Spanish rule. They joined the Mexican Empire the next year. In 1823, the Central American states withdrew from Mexico and formed the United Provinces of Central America. The union began to collapse in 1838, and Costa Rica declared its independence.

In 1842, Francisco Morazán overthrew the dictatorship of President Braulio Carrillo and became president. Morazán attempted to revive the union, but his enemies killed him five months after he took office. Weak leaders governed the country until 1849, when Juan Rafael Mora began a 10-year term as president. Mora established Costa Rica's first national bank, its first street-lighting system, and many public schools.

Revolutions and reforms. Since the late 1800's, Costa Rica has had several revolutions. General Tomás Guardia overthrew the government in 1870 and ruled as a dictator for 12 years. He encouraged large-scale cultivation and heavy exports of coffee. His government improved the state school system and built a railway from San José to Limón. In 1917, Federico Tinoco seized the presidency. Political turmoil forced him to resign in 1919, and Julio Acosta became the new leader. Under Acosta and his successors, Costa Rica became a model of democracy and social reform.

In 1948, Otilio Ulate won the presidential election, but the National Assembly declared the results illegal. Colonel José Figueres then led a revolt in support of Ulate to prevent what he said was a threatened Communist takeover. Figueres took office as interim president, reorganized the government, and placed banks under national control. He also replaced Costa Rica's army with a 4,000-member Civil Guard with officers loyal to him. In 1949, Ulate was inaugurated as president.

Figueres, the founder and head of the National Liberation Party, was elected to the presidency in 1953. He raised the minimum wage, expanded the state school system, and increased the tax on imports. In 1955, a band of exiled Costa Ricans staged an air and land invasion of the country from Nicaragua. The revolutionaries tried to overthrow the Figueres government, but were quickly defeated. President Mario Echandi, who served from 1958 to 1962, tried to reduce the government's control over the economy. But the Legislative Assembly blocked many of his proposals. Francisco Orlich was elected president in 1962.

From 1963 to 1965, the volcano Irazú erupted and showered ash over San José and the surrounding countryside. The volcanic eruptions damaged the coffee crop and forced thousands of people to abandon their homes.

Recent developments. Figueres won the presidency again in 1970, succeeding José Joaquín Trejos-Fernández. Figueres retired in 1974. Since 1974, Costa Rica has had an orderly succession of democratic governments. Costa Rican presidents have worked to maintain traditional neutrality in international affairs while at the same time maintaining good relations with the United States. In 1985, several political parties united to form the Social Christian Unity Party.

During the early 1980's, Costa Rica's economy began to decline. The country's economic problems included a high unemployment rate, low earnings from exports, and a large foreign debt. The United States increased its financial aid to Costa Rica in response to the problems. By the end of the 1980's, Costa Rica had reduced its unemployment rate.

Oscar Arias Sánchez, who served as Costa Rica's president from 1986 to 1990, played a leading role in creating a regional peace plan for Central America. He won the 1987 Nobel Peace Prize for his efforts.

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Outline

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Questions

- How did Costa Rica get its name?
- What percentage of the people can read and write?
- What is the national sport of Costa Rica?
- In what year did Costa Rica declare its independence?
- Why did the ancestors of Costa Rica's blacks come to Costa Rica from the island of Jamaica in the late 1800's?
- What are the *cordilleras*?
- In which land region do most Costa Ricans live?
- What are Costa Rica's leading exports?
- What is Costa Rica's chief natural resource?
- What was the United Provinces of Central America?

Costello, John Aloysius (1891-1976), served as prime minister of Ireland from 1948 to 1951 and from 1954 to 1957. In 1948, Costello, then head of the Fine Gael party, took control of the Irish Free State from Eamon de Valera, who had led the state for 16 years. Costello declared the state an independent republic in 1949. De Valera was prime minister between Costello's two terms, and, in 1957, his victory ended Costello's second term. Costello was born in Dublin, Ireland, and received a law degree. He served as attorney general of the Irish Free State from 1926 to 1932. See also **De Valera, Eamon**; **Ireland, History of** (The Republic of Ireland).

Costume. See **Clothing**; **Theatre** (Costume design); **Ballet** (Costumes).

Cot death. See **Sudden infant death syndrome**.

Cotabato (pop. 3,030,256) is a region in the south-central part of the island of Mindanao, in the Philippines. Originally it was a single province. Today it includes four separate provinces: North Cotabato, South Cotabato, Maguindanao, and Sultan Kudarat. The whole region covers an area of 23,854 square kilometres.

The landscape varies considerably. In North Cotabato, low hills, lakes, and plains make up what is known as the Cotabato Valley. In South Cotabato, mountains are fringed by fertile coastlands. In the west, the Muslim province of Maguindanao features highlands, lakes, and beaches. To the south of Maguindanao lies Sultan Kudarat, a green belt where vegetables and fruit flourish all the year round.

Cotabato's favourable climate and fertile soil encourage large-scale farming. Abacá, coconuts, coffee, maize, and rice are grown across Cotabato. Timber is another major agricultural product. Farmers also keep poultry and other livestock. Rubber is an important product in North Cotabato.

South Cotabato is the largest and most populous of the four provinces. It has an area of 7,466 square kilometres and a population of about 1 million. Cotabato as a

whole is sparsely populated. Its inhabitants include Muslims, Cebuanos, Tagalogs, Pampangos, and other ethnic groups.

Côte d'Azur is the eastern end of the Mediterranean coast of France. This area includes part of the French Riviera, a famous holiday resort (see **Riviera**). The name *Côte d'Azur*, meaning *azure coast*, was given to this region because of the beautiful blue of the sea and the sky. Groves of palm and orange trees and gardens of brilliant tropical flowers line the shore. This part of the Mediterranean coast is a health resort area and playground for tourists from all over the world. The chief cities of this area include Antibes, Cannes, and Nice in France; and Monte Carlo in Monaco.

See also **Cannes**; **Monte Carlo**; **Nice**.

Côte d'Ivoire, République de, is the official name of the Republic of the Ivory Coast, a country that lies along the Gulf of Guinea on the west coast of Africa. See **Ivory Coast**.

Cotillion is one of a family of ballroom dances for four couples in a square formation. These dances were popular from the late 1600's to the 1800's. About 1827, a new style of cotillion became popular as the final event of a ball. The couples sat around the edge of the room while a "gentleman leader" set up gamelike situations called *figures*. Figures included exchanging party favours or forfeiting places, as in musical chairs. There was an element of surprise. A formal ball, at which debutantes are presented, was often called a cotillion.

Cotman, John Sell (1782-1842), a British landscape painter, was noted especially for his early watercolours. He was a leading member of the *Norwich School* of painters.

Cotman was born in Norwich, Norfolk, England. He studied art and exhibited paintings at the Royal Academy in London. Beginning in 1806, he worked mainly in Norwich, where he taught drawing and exhibited his paintings with the Norwich Society of Artists. Cotman moved to Yarmouth in 1812 and worked there on ar-



Attractive villages line the Côte d'Azur along the eastern Mediterranean coast of France. Visitors enjoy this popular resort area because of its balmy climate and natural beauty.



The Drop Gate, by John Cotman, shows the artist's skill in rendering delicate effects of light and shade.

chaecological drawings. In 1834, Cotman became professor of drawing at King's College, London.

Cotopaxi, in the Andes Mountains of Ecuador, is one of the highest active volcanoes in the world. It is 64 kilometres south of Quito, Ecuador. Its nearly perfect cone, with slopes of about 30 degrees, rises 5,897 metres above sea level, and is covered with glaciers and snow fields. Its crater is about 792 metres across. During the

last 400 years, it has erupted more than 25 times. Lava and hot ash cause snow on the flanks of the cone to melt rapidly, sending big flows of mud pouring down the mountainside. An explosive eruption occurred in February 1942.

See also **Mountain** (picture chart).

Cotswold (pop. 73,000) is a local government district in Gloucestershire, England. The mainly rural area, which is almost entirely a conservation area, includes most of the famous Cotswold Hills. The chief town in the district is Cirencester, site of the Roman town of Corinium. Tourism is the main industry. Other industries include agricultural engineering, light engineering, printing, and turkey processing. See also **Gloucestershire**.

Cotswold Hills, in southwestern England, is a range of limestone hills famed for its beautiful scenery and attractive houses built in local *Cotswold stone*. The area has many historic buildings, and tourism is the main industry. The Cotswolds extend from near Bath, in Avon, northeastwards through Gloucestershire, nearly as far as Stratford-upon-Avon, in Warwickshire. The highest point is Cleeve Cloud, 330 metres above sea level. Cleeve is near Cheltenham, Gloucestershire, on the range's western edge. Most of the Cotswolds are rolling hills.

Cottage industry was a home-based system of manufacturing widely used during the 1700's and 1800's. Cottage industry basically involved rural families adding to their agricultural income by making products in the home. A merchant provided the raw materials, collected and marketed the finished item, and paid the family a percentage of the price he received. The most important products made by cottage industry were cloth and clothing. Other products included shoes, cigars, and hand-decorated items.

The term *cottage industry* also refers to any present-day industry in which goods or services are produced at home. Some hand-decorating, sewing, and other highly specialized activities still operate as cottage industries. In addition, some economists point to the rise of a new cottage industry as office paperwork is increasingly handled by people using computers at home.



The Cotswold Hills are formed of limestone, which is exposed in many places on the range's western side. The Devil's Chimney, a limestone column near Cheltenham, is a famous landmark.



A field of cotton produces fluffy white bolls at harvesttime. A woman in India picks cotton by hand, left. The photo on the right shows a ripened boll that has split open.



Cotton

Cotton is the most widely used of all plant fibres. Cotton fibres are woven into soft, strong, absorbent fabrics to make clothing, bedsheets, carpeting, tablecloths, and other items. Other parts of the plant provide raw materials for a wide variety of useful products.

People have cultivated the cotton plant and woven its fibres into cloth for thousands of years. Today, cotton is a part of almost every person's life. Most people use cotton products daily, and many people have jobs in the cotton industry.

The leading cotton growing countries are China and the United States. India, Pakistan, and Uzbekistan also produce large cotton crops. Together, these five countries grow about three-quarters of the world's cotton.

Uses of cotton

All parts of the cotton plant are useful. The most important part is the fibre, also called the *lint*, which grows out of the seeds that are inside the cotton *ball* (seed pod). Textile mills spin the fibres into yarn and weave the yarn into fabric. The *linters* (very short fibres on the seeds) are used in making padding, paper, explosives, and other products. Oil from cotton seeds forms the

base of many food products. Farmers plough under the stalks and leaves to fertilize the soil. Even the hulls of cotton seeds are useful, serving as livestock feed and as a soil conditioner to improve the texture of the soil.

Cotton fibres are used mostly to make clothing. There are various types of cotton fibres that can be woven into fabrics for different kinds of garments, from rugged work clothing to delicate dresses. Unlike other fibres, the cotton fibre can absorb moisture in its centre. This makes cotton clothing feel cooler in summer and warmer in winter than other clothing does because it moves moisture away from the wearer's skin. Clothing made of cotton is also durable because the fibres are strong.

Cotton seeds are used in a wide variety of goods. Manufacturers use the linters from the seeds as raw materials for rayon, paper, photographic film, and other products. Linters are also used to stuff mattresses, cushions, and pads. Bleached, sterilized linters are made into medical cotton pads.

Refined cottonseed oil is a popular cooking oil. It is also a main ingredient of such foods as salad dressing and margarine. Unrefined cottonseed oil is used to make soap, cosmetics, and drugs.

The cottonseed meal that remains after oil extraction serves as livestock feed and plant fertilizer. The cotton



A mechanical cotton picker pulls cotton from the bolls and blows it into a large steel basket at the back of the machine.

seed's protective covering, called the *hull* or *seed coat*, is used for animal feed and as a soil conditioner. Manufacturers also use the hulls to make plastics and synthetic rubber.

The cotton plant

In most parts of the world, the cotton plant is grown as an *annual*—that is, as a plant that grows and dies within one growing season. This section describes the upland cotton plant, from which about 90 per cent of the world's cotton crop is produced.

Appearance. The mature upland cotton plant ranges from 0.6 to 1.5 metres in height and has spreading branches. Depending on growing conditions, each branch may produce from one to several bolls. The plant's leaves are 7.5 to 15 centimetres wide, some with three or five lobes in them and others with no lobes. The plant's *taproot* (long main root) may grow as deep as 1.2 metres into the ground.

How the plant develops. Farmers in most countries plant cotton seeds in the spring. Cotton seedlings emerge from the soil about a week after planting. Approximately three weeks later, *squares* (flower buds) begin to emerge on the plants. New squares continue to appear for about eight weeks. Each square grows for about three weeks and then opens into a creamy-white

flower. The flower has five petals, which are surrounded by leaflike structures called *bracts* and specialized leaves known as *sepals*. The open flower measures about 5 centimetres across.

Within three days after opening, the petals turn pink and then reddish-purple as they dry and fall off. The flower must be pollinated during the first day it is open. Each flower usually pollinates itself.

After the petals fall, the seed pod develops into a boll. Inside the seed pod are about 20 to 40 seeds with fibres and linters growing from them. The seed pod matures into a green, walnut-sized boll in about six to nine weeks. Then the boll begins to dry and split open. The open dried boll, called a *bur*, curves back and exposes the fibres and seeds for harvest.

Kinds of cotton

Scientists have identified 39 *species* (kinds) of cotton plants. Only 4 of the 39 are cultivated. They are (1) *upland*; (2) *Pima*, also called *Egyptian* and *American-Egyptian*; (3) *tree*; and (4) *Levant*. The different *species* resemble each other in most ways. But they differ in such characteristics as height, type of fibres, and blooming time and colour of flowers. Each *species* has varieties with different qualities. For example, some varieties

Cotton terms

Bale is a bundle of raw cotton. A bale weighs between 170 and 227 kilograms.

Boll is the rounded mature seed pod of the cotton plant.

Boll weevil is a beetle whose young feed on cotton *squares* (buds), making them fall off.

Bur is the opened seed case of the cotton plant.

Carding is a process of cleaning and straightening cotton fibres.

Drawing is a process that further straightens the cotton fibres after carding and forms them into a loose rope called a *drawn sliver*.

Ginning is the process of separating the cotton fibres from the seeds.

Grey-state cloth, also called *grey goods* or *greige*, is cotton fabric in its natural, greyish-white colour before bleaching or dyeing.

Lint is raw ginned cotton that is ready for baling.

Linters are the short fibres that remain on the cotton seed after ginning.

Mercerization is the application of an alkaline solution to cotton cloth or thread to strengthen the cotton, make it hold dye better, and give it lustre.

Picker is a machine that separates and cleans the fibres of cotton.

Pima cotton is a type of cotton with strong, silky fibres used to make fine, smooth fabrics.

Roving is a thin strand of cotton fibres ready for spinning.

Sizing is a mixture of starch, gum, and resins that strengthens cotton yarn to better withstand weaving or other finishing.

Sliver is a loose rope of cotton fibres. A *card sliver* is thicker and has more tangled fibres than a *drawn sliver*.

Squares are the buds of cotton blossoms.

Staple is the average length of cotton fibres.

Trash is a term for leaves, stems, and other unwanted plant material in harvested cotton.

Upland cotton is the most common type of cotton.

grow best on irrigated land, and some have stronger fibres than others.

The four main species fall into two groups: (1) *New World cotton* and (2) *Old World cotton*.

New World cotton includes upland and Pima cotton. These types of cotton were first cultivated thousands of years ago by Indians in Central and South America and are probably native to these regions.

Upland cotton is cultivated in many parts of the world. The species may have been named in the American Colonies. There, it was cultivated inland or, as the colonists said, "up land" from the Atlantic Coast. Upland fibres measure from about 2 to 3 centimetres long. They can be made into many kinds of fabrics, including heavy canvas and fine, expensive cloth.

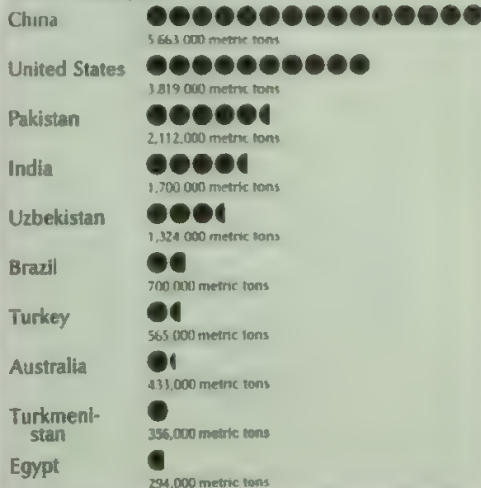
Pima cotton is one name for a species that developed along the coasts of what are now Peru and Ecuador. American colonists cultivated the species as *Sea Island cotton* along the southeast Atlantic Coast of what is now the United States. Scholars believe that growers in the early 1800's crossed Sea Island cotton with a variety of the same species in Egypt. Varieties developed from this cross were brought to the United States in the early 1900's and became known as *American-Egyptian cotton*. Cotton marketed today as Pima is descended from the original Pima (or Sea Island) cotton and American-Egyptian cotton.

About 8 per cent of the world's cotton is Pima, Egyptian, and American-Egyptian. The fibres, which are usually 3.5 to 4 centimetres long, are much stronger than upland cotton fibres. Cotton from this species is used primarily to make high-quality blouses and shirts. It is also used to make sewing thread.

Old World cotton includes *tree cotton* and *Levant cotton*. These species are native to northern Africa and parts of Asia and are also called *Asiatic species*. Levant cotton was an important source of lint for centuries in

Leading cotton-growing countries

Tons of cotton grown in a year



Figures are for 1991
Sources: Food and Agriculture Organization of the United Nations, United States Department of Agriculture

the Old World until other species were introduced and became more profitable. Old World species are relatively unprofitable because they have short, coarse fibres and low crop yields. Today, most of the Old World cotton that is cultivated is used in the communities where it is grown.

Where cotton is grown

The cotton plant originated in the tropics, which have warm to hot temperatures the year around, and it is con-

How cotton develops

An upland cotton plant produces one to several flowers on each branch. After the petals fall, the seed pod develops into a boll. The boll then matures and opens.



An open flower has creamy-white petals and measures about 5 centimetres across. The flower remains on the plant for about three days before the petals fall.



A cross-section of an unopened boll shows the silky white fibres and brownish seeds inside. An unopened boll is approximately the size of a walnut.



Cotton fibres are exposed when the boll dries and splits open. The fibres, which have seeds within them, are called *seedcotton*. Farmers harvest cotton at this stage.

Cotton-producing areas of the world

Cotton grows in many regions of the world. The leading cotton-producing countries are China and the United States. Pakistan, India, and Uzbekistan also produce large cotton crops.



sidered a tropical plant species. Today, however, more than 50 per cent of the world's cotton grows in temperate regions—that is, regions north of 30° latitude that have hot summers and cold winters. Farmers plant cotton mostly in areas that have 200 or more days a year in which temperatures do not drop below freezing.

Leading cotton-producing countries. The world's two largest producers of cotton are China and the United States. China produces about a quarter of the world's cotton, and cotton textiles are a leading Chinese export. Cotton in China grows mainly in the east-central part of the country, near Beijing and Shanghai.

The United States grows about one-fifth of the world's cotton, mostly in the South and Southwest. Texas, California, and Mississippi produce almost two-thirds of the country's cotton.

Other countries. In addition to China, other leading cotton-producing countries of Asia include India, Iran, Kazakhstan, Pakistan, Syria, Turkey, Turkmenistan, and Uzbekistan. Important South and Central American producers include Argentina, Brazil, Colombia, Mexico, Paraguay, and Peru. Egypt, Ivory Coast, Mali, Sudan, and Zimbabwe are the main cotton-producing countries in Africa. In Europe, cotton grows mainly in Greece and Spain. Australia also produces a large cotton crop.

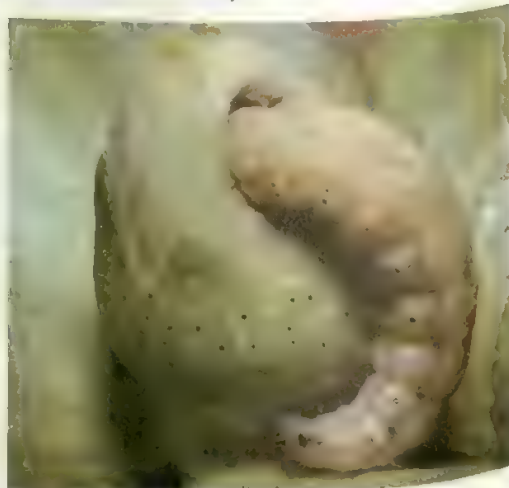
How cotton is grown

Cotton requires a warm to hot climate and a growing season that has many sunny days. The plant grows best in fertile, well-drained soil that gets adequate moisture during the growing season. Sunny weather after the bolls open helps dry the fibres for harvest.

Soil must be rich in nitrogen, potassium, phosphorus, and certain other nutrients to produce a good cotton

crop. In industrial nations, most farmers apply these elements to the soil in the form of chemical fertilizer. In developing nations, the nutrients may come from the addition of animal manure.

Preparing the soil. Most farmers plant cotton seeds between February and June. Growers *till* (plough) the soil sometime between the last harvest and the new planting season. Tilling loosens the soil so that each seed comes in contact with soil on all sides and thus can absorb moisture for sprouting. Tilling also ploughs under remains from the previous season's crop.



A bollworm is a caterpillar that eats the buds and bolls of cotton plants. Bollworms are among the most destructive insect pests.

This material decays in the soil and fertilizes the new crop. In industrial countries, farmers till the land mainly by machine. In less industrial countries, people or animals pull the ploughs. In areas with severe erosion or little topsoil, farmers do little or no tilling.

Planting is done by machines in most industrial nations, and by hand in developing nations. After tilling, most farmers prepare *beds* (low ridges) in which they plant the cotton seeds. Planting in beds rather than on a flat field warms the seeds and drains excess moisture away from the seedlings. *Furrows* (narrow grooves) between the beds carry irrigation water. In hot, dry areas, farmers may plant the seeds on a flat field or between extremely low beds to capture rainfall for sprouting and growth.

Care during growth is important in producing a successful cotton crop. Cotton farmers must control diseases, insects, and weeds.

Diseases of cotton fall into four categories: (1) seedling diseases, (2) wilt, (3) blight, and (4) rot. Seedling diseases are caused by fungi. Cold, wet soils that slow or stop seedling growth help bring on these diseases. To kill fungi, farmers treat cotton seeds with chemicals before planting or add chemicals to the soil along with the seeds at planting.

Wilts, blights, and rots are symptoms of plant diseases caused by specific bacteria and fungi. The infections stunt the growth of plants or cause them to wilt or rot. Farmers can best prevent these diseases by planting cotton varieties that are resistant to the disease-causing organisms and by using proper growing techniques. One such technique is to alternate the planting of cotton with crops that do not support disease-causing organisms.

Insects destroy an estimated 15 per cent of the world cotton crop each year. Various types of bollworms and boll weevils do most of the damage. Whiteflies leave a sticky film on the fibres that makes them difficult to process and causes an unsightly mould to grow on them. Cotton growers control insects mainly with chemical insecticides (see *Insecticide*).

Some insects, such as the bollworm, boll weevil, and tobacco budworm, have developed resistance to some insecticides. In addition, some insecticides have undesirable environmental effects, such as killing helpful as well as harmful insects. As a result, cotton growers have turned increasingly to other methods of insect control. For example, they use such natural enemies as ants, assassin bugs, and spiders to control cotton pests. Other methods of pest control include the use of *microbial agents* and *pheromones*. Microbial agents consist of bacteria and viruses that attack cotton pests. Pheromones are chemical scents released by insects and other animals as a form of communication. Farmers use the sex-attractant pheromones of harmful insects to bait traps.

The development of insect-resistant varieties of cotton has also helped to decrease farmers' reliance on chemical insecticides. In some areas, farmers destroy cotton stalks after harvest so that insects cannot live on the stalks. Some farmers try to keep areas near cotton fields free of vegetation that could provide food for harmful insects.

Weeds reduce cotton crop yields by robbing the



Many aspects of cotton production are carried out by hand in some countries. A cotton picker, *above*, works in China

plants of moisture and nourishment. There are several ways to control weeds. In many developing countries, farmers remove weeds by hand. Nearly all farmers grow cotton in rows to make weed removal easier. Growers in some countries plough weeds under the soil to serve as fertilizer. Most cotton farmers in industrial nations use weedkillers called *herbicides* to control weeds. These chemicals prevent weeds from sprouting or kill them after they appear (see *Herbicide*).



The harvested cotton in India is stored, *above*, ready for sorting. Cotton is harvested about six months after planting.



Bales of cotton are stacked and moved by a fork-lift truck. Cotton is compressed, wrapped, and tied into rectangular-shaped bales after the ginning process is completed.

Harvesting of cotton usually occurs about 150 to 200 days after planting. Many developing nations harvest by hand. Producers in most industrial nations use machine harvesters. Some countries use both methods. The following section describes machine harvesting.

Before harvest, many farmers apply a chemical called a *defoliant* to the crop. Defoliants cause the leaves to fall off, thus reducing the amount of *trash* (unwanted plant material) in the harvested cotton. Trash lowers the value of cotton by causing flaws in yarn and cloth.

Growers use either a *spindle picker* or a *stripper machine* to harvest cotton. The spindle picker has a series of barbed *spindles* (rods) that revolve as the machine moves along a row of cotton. The *seedcotton* (lint and seeds) catches in the spindles and is pulled from the bur. The machine then removes the seedcotton from the spindles and blows it into the picker.

Like spindle pickers, stripper machines pick seedcotton. But strippers also pull the burs and, in many cases, some leaves and stems off the plants. As a result, seedcotton harvested by a stripper machine contains much more trash than that harvested by a spindle picker.

After harvest, many farmers use a large machine to press the seedcotton into *modules* (compressed stacks) that weigh about 9,000 kilograms. Farmers store the modules on or near the cotton field until they are transported to a cotton gin. Other farmers load the seedcotton from the picker or stripper into large trailers and take the cotton immediately to the gin.

Processing and marketing

The processing and marketing of cotton varies from country to country. This section describes these activities in most industrial nations.

Ginning and baling. The term *cotton gin* applies to the entire mechanical system that performs a process called *ginning*. Ginning separates the fibres from the seeds, dries and cleans the fibres, and then bales the cotton. The machines that separate the fibres from the seeds are also called *gins*.

Upland cotton is ginned on a *saw gin* that grabs the fibres and breaks them away from the seeds. Pima cotton fibres are not as firmly attached to the seeds as upland

fibres and so can be removed with a *roller gin*. This type of gin passes the seedcotton between two rollers that squeeze the seeds out from the fibres.

After separation, special machines clean and dry the fibres. The fibres are then compressed, wrapped, and tied into rectangular bales. The weight of the bale varies from country to country. In China, bales weigh an average of about 80 kilograms each; in Egypt, about 325 kilograms; in India and Pakistan, about 165 kilograms; in Sudan, Tanzania, and Uganda, about 180 kilograms; and in the United States, about 225 kilograms. Many of the seeds removed during ginning can be transported to oil mills or sold to ranchers and dairy farmers as cattle feed. Some seed may be returned to the farmer for planting the next season's crop.

Classing. Before farmers sell their cotton on the market, fibre samples are usually evaluated by a government agency. In most countries, cotton is grouped into *lots* of 100 bales, with samples being taken from each lot for *classing* (classification). Only in the United States, Australia, Israel, and a few other smaller producers are samples taken from each bale for classing. In the United States until 1991, inspectors known as *classers* graded the bales on the basis of three characteristics: (1) the whiteness of the lint, (2) the amount of trash in the bale, and (3) how well the cotton was ginned. The classers also estimated how long the longest fibres were and called this estimated length the cotton's *staple*.

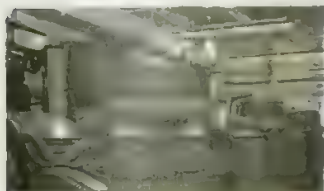
Today, the U.S. Cotton Classing Office also uses devices called *High Volume Instruments (HVI's)* to test and classify samples. HVI's measure fibre length (or staple), strength, and diameter.



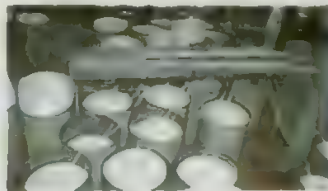
A worker in Thailand, above, uses a hand loom to weave cotton. In industrial countries, this work is done by machine.

How cotton cloth is made

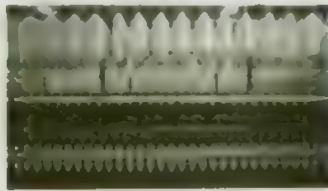
At a textile mill, *carding machines* form cotton fibres into ropes called *slivers*. The slivers are drawn into a strand known as a *roving*, which is spun into yarn. In *warping*, the yarns are wound onto a huge spool. A *slashing machine* feeds the yarn through a mixture that strengthens it for weaving.



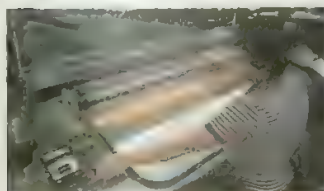
Carding the fibres



Forming the roving



Spinning the yarn



Warping



Slashing



Weaving

Selling. After classing, many farmers sell their cotton to a *broker*, also called a *cotton buyer*. Brokers, in turn, sell the cotton to shippers or textile mills. Some farmers sell directly to shippers or mills. Other producers pool their cotton to sell it in large blocks at competitive prices to shippers or mills. In China and Uzbekistan, two of the largest producing countries, all cotton is purchased by the government at fixed prices.

Sales to textile mills in the United States usually take the form of *forward contracting*. In such a transaction, a mill agrees with a broker or farmer to buy a specific amount of a certain quality of fibre at a given price at a specified future time. This transaction, called a *forward contract*, may occur before planting or during the growing season.

In the United States, cotton of average quality can also be bought and sold on the New York Cotton Exchange in the *futures market*. In this system, traders buy or sell contracts to receive or deliver a certain quantity of cotton at a specified future time. The price they pay is based on their own estimate of what the future price will be. Buyers seldom actually receive the product for which they buy a contract. Instead, they sell the contract before delivery of the goods. If the price of cotton goes up after they buy the contract, they make a profit when they sell the contract. If the price goes down, they sell the contract at a loss.

Making cotton into cloth

After cotton is harvested, ginned, and sold to textile manufacturers, spinning mills make it into yarn. The yarn is then made into cloth.

Cleaning and blending. At the mill, workers remove the wrapping and ties from the bales. They then peel layers of cotton from the bales and place them on conveyor belts. The belts move past spikes that fluff the cotton. The cotton then goes to machines that blend the fibres from different bales into a more even mixture. Once the cotton is blended, machines further clean and

fluff the fibres and remove leaves, stems, and hulls.

In most mills, the fibres then move through a series of air ducts to a *carding machine*, which straightens the fibres into a thin, filmy sheet. A machine then forms the sheet into a loose rope called a *card sliver*, which is coiled into large cans. In some mills, the carding operation includes additional combing to clean the fibres.

Spinning accomplishes three tasks. (1) it reduces the card sliver from a thick rope to slender yarn, (2) it straightens the fibres, and (3) it twists the fibres into yarn. First, the card sliver is pulled into a series of rollers. In a process called *drawing*, the rollers make the sliver thinner and the fibres more parallel. Drawing turns the card sliver into a more slender rope called a *drawn sliver*. Machines then pull the drawn sliver into a still thinner strand called a *roving*. The roving goes through additional drawing and is then twisted into yarn.

Lengths of yarn are tied end to end and wound on bobbins. In a process called *warping*, the yarn is wound onto a large spool called a *beam*. A *slashing machine* unwinds the yarn from the beam and dips it into a vat of *sizing*. Sizing is a mixture of starch, gum, and resins that strengthens the fibres so they can better withstand weaving. After drying, the yarn is made into cloth by weaving, knitting, or other processes. Newly woven cotton fabric is greyish-white and is called *grey-state cloth*, *grey goods*, or *greige*.

Finishing is the final step in the production of woven goods. This process removes contaminants from the cloth and produces white fabrics that easily absorb dyes. Finishing consists of desizing, scouring, bleaching, and a process called *mercerization*.

Desizing soaks the fabric to remove the sizing. Machines then *scour* (wash) the fabric with a special solution to remove naturally occurring waxes from the fibres. *Bleaching* makes the fabric uniformly white so it can be sold as white fabric or evenly dyed. *Mercerization* is the application of a sodium hydroxide solution or other strong alkaline solution to the cloth. This process



Currier and Ives lithograph (1884) of a painting by William Alken Waller

Cotton plantations in the Southern United States often covered 1,000 hectares or more. This scene shows field hands picking cotton on a plantation along the Mississippi River.

improves the lustre of the fabric and makes it absorb dye more evenly.

After finishing, cotton that has not already been dyed before spinning or as yarn is dyed as fabric. The dyeing process is one of the most environmentally damaging in the clothing industry. Recently, however, developments have been made in growing naturally coloured cotton that does not require chemical dyes.

History

Early days. Cotton plant species developed in both the Eastern and Western hemispheres. The oldest remains of cotton in the New World are fossilized plants dating from about 2900 B.C. found in present-day Mexico. In what is now Peru, Indians twined cotton to make fishing nets and other items as early as 2500 B.C. The earliest woven cotton dates from about 1900 B.C. in that same area. Indians in present-day Mexico and Peru used cotton extensively by about A.D. 1000.

The oldest evidence of cultivated Old World species, from about 2700 B.C., is cotton thread and fabric from the Indus River Valley region in what are now Pakistan and western India. The region first exported cotton textiles to Mesopotamia, an area that included most of modern-day Iraq and parts of Syria and Turkey, about 1500 B.C. Residents of Mesopotamia and nearby areas began cultivating their own cotton plants about 700 B.C. Europeans first grew and wove cotton in present-day Spain and Italy in the A.D. 700's. During the next several hundred years, cotton cultivation and weaving spread throughout much of Europe.

England. By the 1500's, imported cotton textiles had become common in England. The English began to weave cotton in the 1600's. They imported raw cotton from countries bordering the Mediterranean Sea, and later from America's Southern Colonies. In a system of production called the *cottage industry*, people spun and wove cotton at home and sold the cloth to merchants.

In the cottage industry system, the supply of woven cotton textiles could not keep up with the demand from merchants. This spurred the development of machines that could process cotton in large quantities. These ma-

chines, invented in England in the 1700's, were crucial in bringing about the Industrial Revolution, a period of rapid industrialization. They also made England one of the largest producers of woven cotton goods.

The first significant improvement in machinery for cotton processing was the *fly shuttle*, developed in 1733 by John Kay, an English inventor. The shuttle increased weaving speed by weaving the yarn mechanically rather than by hand. As a result, weavers needed more cotton yarn than before.

The *spinning jenny*, invented about 1764 by a weaver named James Hargreaves, enabled spinners to provide more yarn more quickly to weavers. It was the first machine to spin more than one yarn at a time. The *water frame*, invented by Richard Arkwright in 1769, spun yarn even more quickly by running on water power. Ten years later, a weaver named Samuel Crompton invented the *spinning mule*. This machine combined features of the spinning jenny and the water frame and gradually replaced both.

American colonists began growing cotton in the early 1600's. They wove cotton into coarse cloth for their own use. In the United States, large-scale cotton growing began in the South in the late 1700's. The colonists exported raw cotton to England, where it was made into textiles. Raw cotton exports from the American states to England increased tenfold between 1780 and 1800, and the Southern states became the single largest supplier of cotton.

English manufacturers tried to keep the new spinning and weaving machines out of the United States. They wanted the United States to continue to sell its raw cotton to England and to buy back finished cloth. But Americans wanted to manufacture their own textiles. Finally, in the 1790's, the first American cotton mills were built in New England. Other mills soon sprang up.

In 1793, Eli Whitney developed a cotton gin that provided a fast, economical way to separate the cotton-seeds from the fibres. This gin could do the work of 50 people and made it possible to send more cotton to the mills. Cotton textile manufacturing in New England grew rapidly.

With the invention of Whitney's cotton gin, the cotton industry in the southern United States also expanded. The slave population grew in the early 1800's as Southern planters required more and more people to pick and gin cotton. Many Northerners opposed slavery, and this conflict became one cause of the American Civil War (1861-1865). As a result of Union (Northern) blockades during the war, American exports of cotton were drastically curtailed. Other countries such as India, Egypt, and Australia had to increase their production in order to meet the demand, thereby developing and expanding their own cotton industries.

In the 1830's, some cotton mills had begun to process cotton seeds in an attempt to extract cottonseed oil. But oil extraction was unsuccessful until just after the American Civil War, when more efficient machines came into use. Selling cottonseed oil then became profitable, and the number of mills processing cotton seeds grew.

The boll weevil began to damage U.S. cotton crops in the 1890's. This beetle, native to Mexico and Central America, had spread into Texas, and by the early 1900's, it had multiplied across much of the South.

American cotton growers successfully fought off the boll weevil by modifying their growing methods. They picked and burned infested squares and bolls. They also planted cotton rows further apart so that heat from additional sunlight would kill developing weevils. The cotton industry recovered in the 1920's, by which time American growers were providing over 50 per cent of the world's cotton. However, the American industry faltered again in the 1930's during the Great Depression, a severe worldwide economic slump.

Synthetic fibres. By 1960, the cotton industry was again thriving, and cotton accounted for about three-quarters of all fibres used in the United States, and about 70 per cent of the world market. But this domination of the market began to decline as synthetic fibres became increasingly popular. By 1979, cotton's share of the world market had been reduced to 47 per cent.

However, in the 1980's cotton resumed its popularity over non-cotton fibres, and cotton consumption increased more rapidly than that of other textiles. Demand grew partly because people wanted softer, more comfortable clothing than synthetics could provide. The increase also resulted from a drop in the price of cotton goods, and the wider availability of high-quality blends of cotton and synthetics. By 1990, cotton had rebounded to make up nearly half of the total fibres used.

Technical advances. Farmers, researchers, and manufacturers are working to solve the problems that still face the cotton industry. Scientists have identified what makes some types of cotton plants resistant to certain pests. They are attempting to develop varieties that are naturally resistant to insects and diseases. Manufacturers are also developing ways of improving trash removal and methods of detecting and removing fibres damaged during manufacturing.

Scientific classification. Cotton makes up the genus *Gossypium* in the mallow family, Malvaceae. There are about 40 species, but only 4 of them are cultivated. Upland cotton is *G. hirsutum*. Pima cotton, Sea Island cotton, and American-Egyptian cotton are common names for *G. barbadense*. Tree cotton is *G. arboreum*. Levant cotton is *G. herbaceum*. Each of these four species includes several varieties.

Related articles in World Book include:

Cotton cloths

Broadcloth	Canvas	Flannel	Muslin
Brocade	Chenille	Gabardine	Percalé
Calico	Corduroy	Gingham	Swiss
Cambric	Denim	Jersey	Voile

Other related articles

Boll weevil	Cottonseed oil	Rayon	Thread
Brown lung	Guncotton	Spinning	Weaving
Cotton gin	Pink bollworm	Textile	Whitney, Eli

Outline

I. Uses of cotton

A. Cotton fibres

B. Cotton seeds

II. The cotton plant

A. Appearance

B. How the plant develops

III. Kinds of cotton

A. New World cotton

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IV. Where cotton is grown

A. Leading cotton-producing countries

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V. How cotton is grown

A. Preparing the soil

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D. Harvesting

VI. Processing and marketing

A. Ginning and baling

C. Selling

B. Classing

VII. Making cotton into cloth

A. Cleaning and blending

C. Finishing

B. Spinning

VIII. History

Questions

Which parts of the cotton plant are made into manufactured products?

Which species of cotton produces about 90 per cent of the world's annual cotton harvest?

What are the four main kinds of cotton diseases?

How do cotton farmers control weeds?

Who invented the cotton gin that stimulated the U.S. cotton industry in the early 1800's?

What tasks does spinning accomplish?

Why did the demand for cotton fabrics increase in the 1980's?

What is mercerization? What does it do?

Why did English manufacturers want to keep new cotton spinning and weaving machines out of the United States in the late 1700's?

Cotton, Sir Henry (1907-1987), was one of the United Kingdom's leading professional golfers for more than 20 years. He was British Open champion in 1934, 1937, and 1948. He also won the open championships of Belgium, Czechoslovakia, France, and Germany, and three times won the Professional Golfers' Association championship. He was Ryder Cup captain in 1939, 1947, and 1953. Cotton was born at Holmes Chapel, in Cheshire, England, and named Thomas Henry Cotton. He was awarded a knighthood just after his death. See also **Golf**.

Cotton, John (1584-1652), was a Puritan minister and author. He was born in Derby, England. While serving as vicar of St. Botolph's Church in Lincolnshire from 1612 to 1633, Cotton became widely known as a pastor and preacher. In 1633, he fled to America to escape persecution as a Puritan. While serving with a church in Boston, Massachusetts, Cotton became one of the most respected leaders of New England. Many children memorized his catechism, *Milk for Babies* (1646).

Cotton believed that church and state should be close partners, and he often advised both about proper gov-



The cotton gin above is a model of the one Eli Whitney developed in 1793 to separate cotton fibre from the seed.

ernment. He opposed unrestrained democracy, in which people ruled themselves. Cotton became New England's spokesman against the more liberal views of Roger Williams, founder of the Rhode Island colony.

Cotton, William. See Knitting machine.

Cotton gin is a machine for removing the seeds from cotton fibres. It is widely believed that the American inventor Eli Whitney produced the first cotton gin. However, simple cotton gins were first used in India during ancient times. A version of these gins, the *roller gin*, had reached the American Colonies by the 1740s. In 1793, Whitney invented a faster, more economical way of separating cottonseeds from the fibres. The cotton gin helped make cotton the chief crop of the southern United States.

Roller gins consisted of a pair of grooved wooden rollers that pressed the seeds from the cotton. These gins could remove the seeds from a variety of cotton called *long-staple*. But they could not remove the tightly clinging seeds from *short-staple* cotton. Short-staple cotton was raised only on small plots because it took one person a full day to separate the seeds from 0.45 kilogram of fibre.

Whitney's cotton gin could remove the seeds from short-staple cotton. As the crank on the gin turned, a cylinder covered with rows of wire teeth revolved. The teeth drew the cotton through slots so tightly spaced that the seeds could not enter. A roller with brushes removed the fibres from the teeth and deposited them in a hopper. Whitney's larger gins could process 50 times as much cotton in a day as could 50 people working by hand. Short-staple cotton quickly became a cash crop.

Today, the term *cotton gin* refers to the entire mechanical system that dries, cleans, removes the seeds, and bales the cotton. The machine that removes the seeds from cotton fibre is called a *gin stand*.

See also Cotton; Whitney, Eli.

Cottonmouth. See Water moccasin.

Cottonseed oil is an edible oil made from the seeds of cotton plants. It is used primarily to make cooking fat



A cottonwood has a spreading, leafy crown, which makes it a good shade tree. Cottonwoods thrive in moist soils in many parts of the United States.

and margarine and as a cooking and salad oil.

Cottonseeds consist of 15 to 24 per cent oil. Manufacturers remove the *hull* (outer covering) of the seed and then extract the oil. Most producers obtain the oil by *solvent extraction*. This method involves soaking the seeds in a solvent, which draws the oil from the seed. The southern and southeastern regions of the United States produce much of the world's cottonseed oil.

See also Cotton (Cottonseed products).

Cottontail. See Rabbit.

Cottonwood is a group of large, spreading, poplar trees that grow in the United States. These trees grow quickly and make good shade trees, but are short-lived. Early in spring, their small, greenish flowers droop in long clusters called *catkins*, and form masses of cottony seeds. The shiny green leaves are shaped like a triangle, and have wavy, toothed edges. The thick, dull grey bark splits into ridges and long furrows. Cottonwood trees grow in moist soils, especially along rivers.

The *eastern cottonwood* grows throughout the eastern regions of the United States. *Black cottonwood*, the tallest western broadleaf tree, grows along the Pacific Coast. The whitish or light brown wood of these trees is soft and weak. Manufacturers use it for boxes and crates, furniture, pulpwood, and *excelsior* (wood shavings used as packing material).

Scientific classification. Cottonwoods belong to the willow family, Salicaceae. The eastern cottonwood is classified as *Populus deltoides*. The black cottonwood is *P. trichocarpa*.

See also Catkin; Poplar.

Cotyledon is the leafy portion of a plant's *embryo*. The embryo is the part of the seed from which a mature plant develops. It consists of a *radicle* (short root) and a *plumule* (short bud), connected by a *hypocotyl* (short shoot) that bears one or more cotyledons. Because they form within seeds, cotyledons are also known as *seed leaves*. If a peanut is split apart, the two halves are the cotyledons. The remaining parts of the peanut embryo can be seen where the cotyledons are attached to the embryonic stem.

Flowering plants, called *angiosperms*, have embryos with either one or two cotyledons. Those with one cotyledon are known as *monocotyledons* or *monocots*. Monocots include bananas, pineapples, and maize. Most monocots bear leaves with parallel veins and flower parts in multiples of three. Angiosperms with two cotyledons are called *dicotyledons* or *dicots*. They produce leaves with a netlike pattern of veins and flower parts in multiples of four or five. Beans, marrows, and tomatoes are common dicots. *Gymnosperms* (non-flowering, woody plants) have embryos with two or more cotyledons. Such needleleaf, cone-bearing trees as pines and hemlocks are gymnosperms.

Cotyledons have various functions. In some seeds, such as those of cereal grains, the cotyledon absorbs stored food from the *endosperm* (food storage tissue) of the seed. In other seeds, including those of peas and beans, the stored food is first absorbed by the developing embryo and then deposited in the fleshy cotyledons. When the seed of a pea sprouts, the cotyledons remain underground. In beans, however, the cotyledons appear above the ground and function briefly in *photosynthesis* (see *Photosynthesis*). Other cotyledons, such as those of morning-glories, resemble regular leaves in appearance and function.

See also **Dicotyledon**; **Germination**; **Monocotyledon**; **Plant** (illustration: How a seed develops into a plant); **Seed** (illustration: The parts of a seed).

Cougar. See **Mountain lion**.

Cough is a strong, sudden expelling of air from the lungs. Coughing serves as a body defence that helps rid the lungs of harmful substances, such as pus or blood. But coughing also spreads germs that cause disease.

A person coughs if the lining of the respiratory tract becomes irritated. Certain nerves respond to this irritation, causing the individual to take a deep breath. These nerves also cause the windpipe to close partially. The *diaphragm*, a large muscle that lies under the lungs, contracts rapidly, pushing air out of the lungs. The windpipe then opens and the air rushes through the breathing passages and out of the mouth.

Irritants that produce coughing include smoking, air pollution, and respiratory infections. The irritation may lead to inflammation and cause the layer of mucus in the throat to thicken. Some cough medicines help reduce inflammation and loosen mucus so it can be coughed up easily. Others lessen the activity of certain nerves that produce coughing.

Mucus coughed up from the lungs helps doctors diagnose certain diseases. Doctors examine mucus under a microscope for evidence of bacteria, cancer cells, or other indication of disease.

Coulee Dam. See **Grand Coulee Dam**.

Coulomb is a unit in the metric system measuring electric charge. It is the quantity of electricity that flows through a conductor in one second when the current is one ampere. An electric current carrying one coulomb per second is called a current of one *ampere*. The name *coulomb* was given to the unit to honour the French physicist Charles Augustin de Coulomb.

See also **Ampere**; **Farad**.

Coulomb, Charles Augustin de (1736-1806), a French scientist, inventor, and army engineer, made fundamental contributions in the fields of friction, electric-

ity, and magnetism. He formulated *Coulomb's law*, which states that the force between two electric charges or magnetic poles varies inversely as the square of the distance between them. He invented a number of instruments for measuring magnetic and electric forces. The unit for the quantity of electricity, the coulomb, was named in his honour.

Coulomb was born in Angoulême, in France. He was educated in Paris and entered the French Army. After nine years of army service in the West Indies, he devoted himself to scientific research.

Coulton, G. G. (1858-1947), a British author and historian, wrote many important works on medieval history. These works include *Chaucer and His England* (1908) and *The Medieval Village* (1925). His studies of religion include *Five Centuries of Religion* (1923-1950) and *Defence of the Reformation* (1931).

George Gordon Coulton was born at King's Lynn, in Norfolk, England. He studied at Cambridge University, and at Heidelberg University in Germany. Coulton was professor of medieval history at Toronto, Canada, from 1940 to 1943.

Coumarin. See **Anticoagulant**.

Council, in local government, is the elected local authority of an administrative area. Councils feature in many countries. These include Australia, New Zealand, South Africa, the United Kingdom, and the United States.

In England and Wales, the administrative areas run by councils are counties or districts, except in Greater London, where they are boroughs. Wales also has community councils, semi-official bodies that monitor affairs in areas within districts. In Northern Ireland, there is only one kind of council, which controls a district. The Republic of Ireland has councils for counties, county boroughs, boroughs, and urban districts. Scotland has councils for regions and for districts. Most councillors are elected for three years.

Committees of councillors examine specific questions and make recommendations. The most important committees deal with finance and housing, and with education if the council is an educational authority. Other committees deal with such matters as health, roads, libraries, and parks. Councils employ a number of officials to advise them and to carry out their policies.

See also **Local government**.

Council for Mutual Economic Assistance. See **Common Market**.

Council of Blood. See **Alva, Duke of**.

Council of Europe. See **Europe, Council of**.

Council of Pisa. See **Pisa, Council of**.

Council of Trent. See **Trent, Council of**.

Counselling is the process of helping people to explore and understand personal problems and develop their potentialities. People seek counselling for help in such areas as choice of career, emotional concerns, difficulties in relationships, and personal crises.

Most counselling is based on discussions between a *client* and trained *counsellor* in a confidential setting. Although counsellors sometimes provide their clients with information, such as the results of aptitude tests or information about different careers, they do not normally attempt to solve their clients' problems for them. Instead, clients are helped to clarify their thinking and identify their needs in order that they may overcome dif-

faculties on their own.

Guidance teachers, social workers, members of the clergy, and other professionals use counselling skills as part of their job. Professional counsellors receive formal training, sometimes lasting several years, before working in institutional settings or in private practice. Charitable agencies in many countries also offer counselling by telephone.

Since the 1950's, counselling has developed a number of specialized areas. Among the most important of these are short-term counselling and counselling for couples in a relationship such as marriage. There has also been a great expansion in *post-disaster counselling*. Counsellors who specialize in this area work with people who have suffered the effects of violent crime, war, earthquakes, floods, and other disasters.

See also **Psychotherapy** (Humanistic psychotherapy), **Samaritans**.

Counsellor. See **Lawyer**.

Count is a title of honour going back to the days of the Roman Empire. The Latin word *comes* means *companion* or *follower*, and was used to indicate the companions of the Roman proconsuls. From this came the Spanish title *conde*, and the French *comte*. *Count* came into the English language as a translation of foreign titles equal to the English *earl*.

See also **Earl**.

Counter Reformation is the name generally given to the renewal movement in the Roman Catholic Church during the 1500's and 1600's. Many Catholic scholars prefer the terms *Catholic Reformation* or *Catholic Revival* to avoid the implication that the movement was merely a reaction to the Protestant Reformation.

Reform movements in the church had begun long before the rise of Protestantism. During the 1400's, clergymen such as Girolamo Savonarola in Italy and Francisco Ximenes in Spain began to stir the conscience of the church against abuses that developed during the Renaissance. But the spark that set off a complete renewal of Catholic faith and practice was the rejection of the pope by Protestant reformers. This action awakened the zeal of Catholics to purify the church "in head and members," from the pope down.

Pope Adrian VI, who reigned from 1522 until his death the next year, described the church as it had been just before the Protestant Reformation: "We frankly acknowledge that God permits this persecution of the Church on account of the sins of men, and especially of prelates and clergy. . . . We know well that for many years things deserving of abhorrence have gathered around the Holy See; sacred things have been misused, ordinances transgressed, so that in everything there has been a change for the worse. . . ."

The Counter Reformation took two main forms: (1) a rebirth of faith among the people, and (2) a reassessment of principles by church leaders. Religious zeal was stimulated by the establishment of new religious orders in the early 1500's. With the founding of the Society of Jesus (Jesuits) in 1534, the Counter Reformation became an established fact.

The Council of Trent, held from 1545 to 1563, determined the manner in which Catholic life and worship were to be renewed. The council defined the nature of grace and salvation, the sacrifice of the Mass, the priest-

hood, the seven sacraments, and church authority. It also authorized seminaries for the training of priests, decreed ecclesiastical clothing for the clergy, issued a catechism of doctrine, and required bishops to live in their dioceses. In addition, the council encouraged the establishment of schools; insisted that priests, nuns, and monks practise poverty; and promoted the sending of missionaries throughout the world.

The renewal of faith among Catholics affected every form of art. For example, the baroque movement in painting, sculpture, and architecture is often identified with the Counter Reformation. This movement was characterized by dramatic and emotional works of art. In literature, the English Catholic poets Richard Crashaw, John Dryden, and Robert Southwell wrote intensely spiritual works typical of the spirit of the Counter Reformation. See **Baroque; Painting** (The 1600's and 1700's).

Two factors contributed to the success of the Counter Reformation: (1) the discovery of the New World, and (2) the Industrial Revolution. The colonization of North and South America helped the church realize its desire to extend the frontiers of Christianity. Industrialization brought large numbers of Catholics from rural to urban areas. This migration led to the formation of parishes and Catholic schools, and the development of a distinctive Catholic culture.

See also **Reformation; Roman Catholic Church** (The Reformation and Counter Reformation); **Trent, Council of**.

Counterespionage. See **Espionage**.

Counterfeiting is the unauthorized duplication of any object, especially money, with the intent to *defraud* (cheat someone). The printing and coining of money is the responsibility of national governments. Agreements have been made between different countries to prosecute counterfeiters of coinage of each other's countries. The international organization of police, Interpol, takes a large part in investigating international counterfeiters.

The manufacture of imitation brand-name goods, including clothes, computers, and motor vehicle parts, is called *trademark counterfeiting* or *pirating*. Some producers of the genuine article have difficulty in protecting their intellectual property rights. Counterfeit products are usually inferior to genuine ones. Consumers are defrauded when they buy them, believing they are getting the real ones. Governments of countries where counterfeiting is common take measures to eliminate it. Failure to do so may damage their trading prospects.

See also **Forgery**.

Counterpoint is a musical term for two or more independent melodies performed at the same time. Counterpoint is also called *polyphony*.

There are two basic types of counterpoint, *imitative* and *free*. In imitative counterpoint, a fragment of a theme called a *motif* is performed in different parts successively, often overlapping. The song "Three Blind Mice" is an example of imitative counterpoint called a *round*. Other examples include the *canon* and the *fugue* (see **Canon; Fugue**). Free counterpoint combines two different melodies. In one type, melodies are performed over a repeated pattern in the bass part. Compositions of this type include the *chaconne* and the *passacaglia*. In another type, one melody is performed against a counter-melody. The German composer Johann Sebastian



Country craftworkers still use traditional methods in crafts such as saddlery. Repairing saddles is as important a part of a saddler's work as making new ones.

Bach treated hymns in his chorale preludes in this style.

Counterpoint developed in Europe about A.D. 850. A high point in the use of counterpoint occurred in the 1500s in the works of William Byrd of England, Giovanni Palestrina of Italy, and the northern European composer Josquin Desprez.

See also **Music** (Harmony).

Countess. See **Earl**.

Counting. See **Arithmetic**.

Country is a term that means any independent nation with a definite name and a geographic boundary. The number of independent countries has steadily increased since World War II (1939-1945) as more colonies have become independent. In size, the countries of the world range from Vatican City, which covers 44.0 hectares, to Russia, with 17,075,400 square kilometres.

There are nine huge countries, each with more than 2.6 million square kilometres, and about 65 large ones covering from 260,000 to 2.6 million square kilometres. There are about 30 medium-sized countries with over 100,000 square kilometres; about 50 that include from 7,800 to 100,000 square kilometres; and about 30 small ones covering less than 7,800 square kilometres. For lists of the countries of the world, see the various continent articles, such as **Africa** (table: Independent countries of Africa); also **World** (table: Independent countries of the world).

In a second meaning, the term *country* may refer to a region that is not necessarily a political unit and does not usually have exact boundaries. The Black Country in England is an example.

Country and western music. See **Country music**.

Country crafts, in Ireland or the United Kingdom (UK), include old, traditional activities, such as weaving, spinning, and thatching, and small country industries that have developed from them. In order to keep up

with the needs of modern life, country craftsmen and women have had to develop their skills and adapt themselves to new methods. They have also had to become accustomed to using new materials. Farming and other industries must be well served by an adequate number of skilled craftworkers working within a short distance of each other. Today, there are thousands of prosperous small country industries in all parts of the United Kingdom. They include both the small workshops or homes of self-employed craftworkers and small factories employing several local people.

Some rural industries have no obvious reason for their particular location. But others are located in a particular place for a specific reason. For example, the basketmaking industry of Somerset is located near the *osier* (willow) trees that thrive locally and that provide the raw material for the baskets.

Kinds of country crafts

Country craftworkers may be divided into three categories. *Service craftworkers*, such as the blacksmith, provide a repair service for farm machinery. *Producer craftworkers*, such as the potter, make goods for sale in both the UK or Ireland, and other countries. *Artist craftworkers* make a limited number of articles of especially high quality. Some craftworkers, such as the saddler, are both producer and service craftworkers.

Country craftworkers make goods of high quality that are based mainly on traditional designs. But their work sometimes falls below the standard of design required in modern manufactured goods.

Farriery is the old craft of shoeing horses. It was once the main task of blacksmiths, who form the largest number of country craftworkers. Today, most blacksmiths are skilled agricultural engineers. They repair and maintain the complex machinery used on modern

farms. Many have various machines that have taken the place of the hand-operated bellows and the anvil that characterized the village smithy of the past. As a result of the decrease in numbers of farm horses, few blacksmiths shoe horses today. But the decline in this craft has been halted, mainly as a result of the increase in horse-riding as a pastime. Some smiths are engaged entirely in farriery work, particularly near racecourses.

Saddlery is the old craft of making saddles and harness for horses. Saddlers also have been affected by the decrease in numbers of horses. But, like the blacksmiths, they are today enjoying increased prosperity as a result of the popularity of showjumping, pony trekking, and pony clubs. Few saddlers now make harness. This craft is carried on by a small number of large firms in industrial areas. Most saddlers today give a repair service in saddlery and in sports and travel goods. Saddlery is flourishing in such areas as Newmarket in Suffolk, and a number of apprentices are learning the craft.

Basketmaking is carried on mainly in Somerset and other areas where the osier beds flourish, such as the eastern counties of England, and southern and western Ireland. Some cane is imported, and basketmakers are working in many counties. They have to face serious competition from cheap but well-made baskets imported from other European countries, and also from countries in the Far East. But British craftworkers make some of the finest heavy industrial baskets and hampers used in the agricultural and fishing industries.

Hedging and walling are declining crafts. The decline has been caused by the use of hedge-cutting machines, and by the mechanization of agriculture, which favours the cultivation of large unenclosed areas. In some districts it is almost impossible to find a craftworker skilled in this work. But young farmers' clubs in many areas of the British Isles give instruction and arrange competitions in hedging and walling. Mainly as a result of the work of these clubs, hedging and walling have survived in many areas of England, Wales, and western Ireland.

Pottery and brickmaking are known as *clay industries*, because clay is used to make articles. *Heavy* clay industries include the making of hand-made bricks and tiles. Small country brickyards specialize in making *facing bricks* for the outsides of buildings. Potters are divided into studio potters and horticultural and industrial potters. Their work is in great demand, but some people consider it less interesting than imported pottery. See also **Pottery; Porcelain**.

Textile making was carried on many years ago in all parts of the British Isles, particularly in areas where sheep were reared and in areas of Britain where Flemish refugees settled in the 1600's, such as East Anglia. Little remains of this early craft except in parts of Wales, Scotland, the Scottish islands, and the Republic of Ireland, particularly Donegal. In these areas, small but thriving mills make distinctive tweeds and flannels of high quality.

Thatching was for many years a declining craft. But it is still practised in country districts in the Republic of Ireland, and more than 700 full-time thatching businesses are operating in Britain today. Most are south of a line across England from the Mersey to The Wash. Thatchers use three types of roof-covering: long straw;



Thatchers are still needed in many parts of southern England, Wales, and Ireland. They work putting new covers on the roofs of old houses or repairing thatch.

combed wheat reed; and Norfolk or water reed, which is the most durable of the three.

Wheelwrighting as the separate craft of wheelmaking no longer exists. The wheelwright has become a craftworker who works in various materials, and manufactures trailers, cattle transporters, and portable buildings such as poultry houses. Like most other craftworkers today, the wheelwright uses modern machines and materials.

Other crafts include gatemarking, hurdlemaking, furniture making, and boatbuilding. Boatbuilders working in coastal areas and inland waterways have a high reputation for all kinds of small boats. Some craftworkers specialize in wrought-iron work. They make various items, such as large, ornate gates and railings. Others make goods in copper, steel, and precious metals.

Historical development

During the Middle Ages, craftworkers were encouraged to form guilds to guard their high reputation for honesty and fine work. Many old craft guilds exist today, but few are concerned with the crafts that gave them their name. See **Guilds**.

The Industrial Revolution of the 1700's was a difficult time for country craftworkers. Thousands of skilled men, women, and young people in Britain left their homes and work to get easier employment, and often more pay, in the mills and factories in the towns. Many villages and small towns that had developed small work-



Stars of country music include Hank Williams, *left*, Loretta Lynn, *centre*, and Randy Travis, *right*. Williams was a leading country performer of the 1940's and early 1950's. Lynn first became popular in the 1960's. Travis was one of the most popular country performers of the late 1980's.

shops were left without a single skilled craftworker. See **Industrial Revolution**.

After World War II (1939-1945), country craftworkers enjoyed increased prosperity. The improvement was caused by the great demand for their services, by new patronage from various sources, and by the desire of many people to live and work in the country. Craftworkers in Britain have also been helped by such organizations as the Council for Small Industries in Rural Areas, which is financed by the government, the Crafts Centre of Great Britain, and the Council of Industrial Design.

In the Republic of Ireland, a government-sponsored organization called *Gaeiltearra Fireann* encourages industries, such as weaving, in areas where Irish is spoken. The prosperity of country areas today depends upon maintaining a balance of industry and employment between them and the towns.

Country dance. See **Dancing** (The 1600's and 1700's).

Country music is a type of American popular music associated with rural culture and the Southern region of the United States. It developed in the 1800's, combining elements of folk music from Great Britain, the blues of Southern rural blacks, popular songs of the late 1800's, and religious music. Country music, sometimes called *country and western music*, has been popular throughout the world since the 1940's.

During the 1920's, most country singers and instrumentalists came from such states as Georgia, Kentucky, North and South Carolina, Tennessee, and West Virginia. In the 1930's and 1940's, many artists from Alabama, Mississippi, Oklahoma, and Texas came to prominence. These performers created a wide variety of country music styles that today include bluegrass, Cajun, cowboy music, honky tonk, rockabilly, and western swing.

Characteristics. The musical instruments vary with each type of country music, but some are common to nearly all country groups. Instruments from many areas

of the world combined in the New World to form the core of country music's instrumental sound. These instruments include the fiddle from Great Britain, the banjo from West Africa, the guitar from Spain, and the mandolin from Italy. As country music came under the influence of other kinds of music, other instruments were added and altered the basic sound. The piano, Hawaiian steel guitar, double bass, horns, and reed instruments have all been used in country music. Instruments that were electronically amplified first appeared in country music in the 1930's.

The story told in songs is an important part of country music. Many country songs today use direct language and realistic situations to describe the real concerns of adults. Most country songs are about love and romantic feelings. Many are happy songs, but some explain the feelings of loneliness, loss, and separation that result when love or romance ends, or when married couples are unfaithful. Some country songs are about work. Others express sacred themes, reflecting the importance of religion in Southern life. Some country songs are about events in the news, and some are humorous. Many old folk tunes are still sung in country music.

Styles vary from one style of country music to another. For example, bluegrass and other "mountain music" styles feature a high-pitched, nasal singing tone. Other singers sound like pop music vocalists.

Early years. Country music developed from the folk and religious music of the rural South. Beginning in the 1600's, immigrants from the British Isles brought their folk music to North America. This music included fiddling and singing. Solo fiddlers played dance music at social events, such as country dances, weddings, and wakes (funerals). Ballads and other folk tunes were often sung by one person, alone or accompanied by a fiddle. The religious music of the South included hymns and, beginning in the late 1800's, gospel songs and spirituals.

Folk music in the South changed through contact with other cultures. Between the mid-1800's and about

1920, the banjo, guitar, mandolin, and Hawaiian steel guitar were borrowed from many folk music traditions. Various combinations of these instruments were used both with and without vocalists. By about 1920, the *string band*, consisting of a fiddle, banjo, and guitar, was the standard instrumental group. String bands played dance music and folk tunes in homes, at parties, and at country fairs.

Commercial success. During the early 1920's, country music became available on records and on the radio. Record companies set up temporary recording studios in such Southern cities as Atlanta, Georgia; Charlotte, North Carolina; Dallas, Texas; and Memphis, Tennessee. The music they recorded was often called *hillbilly music*, partly because of a popular band called the "Hill Billies." Sometimes, country entertainers were brought to New York City to record.

Early country radio shows were broadcast from cities as far north as Des Moines, Iowa, and Chicago, but the music was still concentrated in the South. There, it was broadcast from such cities as Atlanta; Dallas; Fort Worth, Texas; Shreveport, Louisiana; and Wheeling, West Virginia. The most important radio programme to feature country music—the "Grand Ole Opry"—was first broadcast from Nashville in 1925 as the "Barn Dance." It is still broadcast today from a theatre in Opryland, an entertainment park near the city.

Country music continued to change in the 1930's. Many groups added drums, pianos, and electric instruments to their sound. The singing style became smoother, and the accompaniments began to contain chords that sounded more like those found in other popular music of the day. In the late 1920's and early 1930's, the famous country singer Jimmie Rodgers performed in a style that combined country yodelling with black blues.

During the 1930's, radio stations broadcast country music to many regions of the United States. At the same time, Southerners moved to other parts of the country, taking their music with them. As a result, country music began to gain national popularity. During World War II (1939-1945), country music gained an international audience when members of the United States armed forces brought records to other countries. The most popular performers of the 1930's and 1940's included Roy Acuff, Gene Autry, the Carter family, Jimmie Davis, Red Foley, Tex Ritter, Jimmie Rodgers, Ernest Tubb, and Bob Wills.

After World War II. During the 1950's, mainstream pop singers recorded hits written by country composer and singer Hank Williams. These songs include "Cold, Cold Heart" and "Your Cheatin' Heart." Kitty Wells was the most popular solo female country singer from the mid-1950's to the mid-1960's.

During the late 1950's and the 1960's, the country music industry produced many records that blended characteristics of country and pop music. Vocal and string background ensembles became common, and much of the music was electronically amplified. This new style of country music was called the *Nashville Sound*. Its leading performers included Eddy Arnold, Patsy Cline, and Jim Reeves.

Country music today. In the 1970's, many country singers became national celebrities, and several became film and television performers. Such singers as Crystal

Gayle, Loretta Lynn, Ronnie Milsap, Dolly Parton, and Kenny Rogers had hit records in both the country and popular markets.

Emmylou Harris, Waylon Jennings, Willie Nelson, and other singers have supported a return to a more basic, authentic country style. Many country entertainers who began careers in the 1980's drew inspiration from the roots of country music. Randy Travis, the Judds, Reba McEntire, and George Strait performed in styles associated with the 1950's and 1960's. Other stars, such as Alabama, Hank Williams, Jr., and Restless Heart, combined country music and rock. Lee Greenwood, Barbara Mandrell, and K. T. Oslin explored the boundary between country music and pop.

Related articles in *World Book* include:

Arnold, Eddy
Autry, Gene

Popular music
Williams, Hank

Country Women's Associations is an Australian organization which supports projects that will benefit people living in rural areas. These include fostering an interest in homemaking and handicrafts, maintaining rest rooms and baby health centres in country towns, and providing holiday homes where country families can find relief from the heat of the inland. Members provide voluntary services in their local areas. The first of these associations was founded in New South Wales in 1922.

County is usually a division of local government. There are counties in several countries, including New Zealand, the Republic of Ireland, the United Kingdom, and the United States. In Australia, the local government area is called a *shire*, although the name county is used for some larger areas.

The United Kingdom and the Republic of Ireland

In the United Kingdom and the Republic of Ireland, counties based on old historic boundaries are called *geographical counties*. Some geographical counties no longer play a part in local government. For example, counties play no part in the local government of Northern Ireland, which is administered as 26 *districts*. Northern Ireland's six counties are now purely geographical divisions.

Counties that do have a function in local government are called *administrative counties*. England, the Republic of Ireland, and Wales have administrative counties. In Northern Ireland, administrative counties were abolished in 1973, and in Scotland in 1975.

Geographical counties. The original county boundaries were based on the old kingdoms and provinces of Britain and Ireland. Historians believe that the first divisions were made in England during the reign of King Alfred, in the A.D. 800's. The areas were called *shires*. In the 1400's, shires became known as counties.

The town in which the county court was held came to be known as the *county town*.

Many geographical counties now have no relationship to the organization of local government through administrative counties. An example in England is Middlesex, which ceased to exist as an administrative county in 1965. But the geographical tradition of Middlesex still continues in some ways. Other purely geographical English counties include Huntingdon and Peterborough, Rutland, and Westmorland.

Administrative counties have their own elected councils to provide local government. The area of an administrative county is, in most cases, similar to the area of a geographical county. But in some areas, population changes have produced geographical counties with small or large populations. The *administrative centre* of a county is the town in which the county council meets, and where the important administrative offices are sited.

England has 39 administrative counties. These were established when England's local government was reorganized in 1974. Some of the administrative counties are subdivisions of geographical counties. Examples are the two counties in Sussex—East and West Sussex.

The responsibilities of the 39 administrative counties include consumer protection, education, fire services, libraries, police, refuse disposal, and social services. Each nonmetropolitan county is divided into a number of *districts*. A district has its own council, with responsibilities that include clean air, food hygiene, housing and slum clearance, public transport, and refuse collection.

London has a unique form of local government. See **London**.

Northern Ireland has six geographical counties. These were abolished for administrative purposes in 1973. Because of the six counties which make up the province, Northern Ireland is sometimes called the *six counties*. See **Ulster**.

Republic of Ireland has 26 geographical counties, and 27 administrative counties, because of the subdivision of Tipperary into two *ridings*.

Scotland has 33 geographical counties. These were abolished for administrative purposes in 1975, and Scotland was subdivided into 9 *regions* plus 3 *island authorities*. The regions are similar in structure and population to the English counties, but are generally much larger in area. See **Region**; **Orkney**; **Shetland**; and **Western Isles**.

Wales is divided into 8 administrative counties. To some extent, these are based on ancient subdivisions of Wales. The only geographical county that is subdivided is Glamorgan. The Welsh counties are similar in powers and structure to the English counties. The present Welsh counties were established in 1974. Previously, Wales had 13 counties.

United States

Almost all the states of the United States are divided into counties. In counties where large cities occupy the entire county area, city and county governments may be combined.

The number and size of counties vary from state to state and from region to region. The United States has 3,049 organized counties. Texas, with 254, has the largest number of counties.

County governments may administer justice, assess and collect taxes, record official documents, and register voters. They may also administer roads and education; manage such functions as sewage disposal; and maintain parks, airports, hospitals, libraries, electric service, and water service.

The word *county* comes from the French *comte*, which was derived from the Latin *comitatus*, meaning *body of companions*. The French county was the domain of a count. The English colonists took the county system with them to America.

Related articles in World Book include:

Coroner
Local government
Shire

County government. See **County**.

Coup d'état is a sudden take-over of a country's government by a group of conspirators. Usually, the conspirators are public officials who infiltrate and then use their country's armed forces, police, and communications to seize power. A coup d'état may lead to few or many changes in the government. Famous coups in history include those carried out by Napoleon Bonaparte in France in 1799, by the Bolsheviks in Russia in 1917, and by the Communists in Czechoslovakia in 1948. During the 1900's, most coups have occurred in politically unstable countries in Africa, Asia, Latin America, and the Middle East. *Coup d'état* is a French term meaning *stroke of state*.

See also **Junta**.

Couperin, François (1668-1733), called "Le Grand" (The Great), was a French composer during the baroque period. Much of his work was written for the *harpsichord*, a keyboard instrument resembling a piano, in which the strings are plucked. For this instrument, Couperin wrote 27 *ordres* (suites) containing more than 200 highly imaginative, picturesque, and elegant pieces. Johann Sebastian Bach studied and sometimes imitated Couperin's style. Couperin also wrote chamber music and church music. In 1716, he published a harpsichord instruction book that is still used by students of the instrument.

Couperin was born in Paris. Many members of his family were also musicians. He became organist at the church of St. Gervais in 1688 and at the royal chapel in 1693. Couperin often performed on the harpsichord before the royal court at Versailles, and he was music teacher to the children of King Louis XIV.

Couplet is a rhyme of two lines. The *heroic couplet* is an English metrical form in iambic pentameter, used in sequence.

A *closed* couplet emphasizes the rhyme, and completes a thought within two lines. For example:

A perfect Judge will read each work of Wit
With the same spirit that its author writ:
Survey the Whole, nor seek slight faults to find
Where nature moves, and rapture warms the mind. . .

In an *open* couplet, clauses and sentences end anywhere, and the rhyme is not emphasized. For example:

A thing of beauty is a joy forever:
Its loveliness increases; it will never
Pass into nothingness; but still will keep
A bower quiet for us, and a sleep
Full of sweet dreams, and health, and quiet breathing.

John Dryden and Alexander Pope used the closed couplet brilliantly. Other poets used open couplets with great skill. They include Geoffrey Chaucer, George Chapman, and John Keats. The word *couplet* also refers to any two lines of poetry that alone form a stanza.

See also **Metre**; **Poetry**; **Rhyme**.

Coupon. See **Rationing**.

Courbet, Gustave (1819-1877), a French painter, helped found the realist movement in art. When Courbet began his career, the dominant art styles in



Oil painting on canvas (1850; the Louvre, Paris)

A Courbet painting called *The Funeral at Ornans* shows about 40 life-sized figures at tending a burial in rural France. The painting caused great controversy when it was first exhibited. Critics objected to the sympathetic portrayal of common villagers. Most people believed only important individuals deserved such dignified and realistic treatment.

France were neoclassicism and romanticism. Neoclassical artists chiefly portrayed historical subjects in a classical style. Romantic artists stressed dramatic and exotic themes. Courbet believed art should show the people and events of the time realistically and honestly.

In 1850, Courbet created great controversy when he exhibited two of his most important paintings, *The Funeral at Ornans* and *The Stone Breakers*. These paintings portray rural society in its native setting. Many urban viewers objected to Courbet's perceptive treatment of rural people. Painters of the time had been portraying these people sentimentally, or as inferior to the urban middle and upper classes. In *The Funeral at Ornans*, Courbet painted the peasants and clergy life-sized. During this period, the peasants had become an important political force. Courbet's portrayal of this new force disturbed conservative critics.

Jean Désiré Gustave Courbet was born in Ornans, near Besançon. In 1840, he moved to Paris. Courbet sympathized with revolutionary movements devoted to ending the French monarchy. He became a member of the Commune, which governed the city briefly in 1871. After the Commune fell, Courbet was imprisoned and fined for his political activities. In 1873, he went into exile in Switzerland. Courbet's paintings later influenced such major art movements as naturalism and impressionism.

See also **Painting** (Realism; picture).

Courgette is a type of small marrow, or squash, that resembles a cucumber. Courgettes are cylindrical, and most have shiny green skin, though some varieties are

golden coloured. Their flesh is greenish-white. Courgettes are mainly eaten cooked and are also used in making a kind of bread. They make up one of the main ingredients of *ratatouille*, a vegetable casserole. People also eat courgettes raw in salads. Courgettes are low in calories, but a good source of calcium, iron, and vitamins.

Courgettes are popular garden vegetables and grow well in climates with at least two months of consistently warm weather. They require a fertile, well-drained soil in a sheltered sunny position. Courgettes are usually planted from seed after all danger of frost has passed. They can be grown in a pot in a greenhouse before being planted outside. The vegetables grow on a bush with a short stem and large leaves. Courgettes are picked when they are 15 to 20 centimetres long and their rind is still tender.

Scientific classification. The courgette belongs to the cucumber family, Cucurbitaceae. It is *Cucurbita pepo*.

See also **Gourd**; **Squash**.

Cursor is the name for a group of desert birds found in Africa, India, and Australia. Most cursors have long legs and short wings. They are normally seen running swiftly over the sand. They seldom fly unless disturbed and then usually fly only a short distance. Cursors have narrow beaks that curve downward. They feed chiefly on insects. Cursors, like the related pratincole, group together after the breeding season (see **Pratincole**).

There are nine species of cursors, most of which are brown and white. They include the cream-coloured cursor of Africa that has a distinct black eye stripe. One species, the Egyptian plover, has bright grey, white, and black markings. The Egyptian plover is common along the Nile River. It is also called the *crocodile bird* because in folk tales the bird is described picking bits of food out from between a crocodile's teeth. The female Egyptian plover incubates her eggs at night and often buries them in the sand during the day to be heated by the sun. In southern Africa, cursors are noted for eating large numbers of locusts and are sometimes called *locust birds*. The Australian dotterel is also usually included in the cursor group. It is rust-red and black, and frequents bare gravel flats. It is known to cover its eggs with earth or sand when leaving the nest.

Scientific classification. Cursors belong to the family Glareolidae. The cream-coloured cursor is *Cursorius cursor*; the Egyptian plover is *Pluvianus aegyptius*, and the Australian dotterel is *Pelthyas australis*.



A single plant produces several courgettes.

Coursing is a field sport, popular in many countries, in which two greyhounds compete in pursuing a hare. People called *beaters* drive a hare towards the *slipper*, the person in charge of the two dogs. When the hare is within sight of the dogs, but far enough away to give it a start, the slipper releases the dogs and they pursue it.

Generally, one of the dogs kills the hare, but it may escape. *Pickers-up* catch the greyhounds at the end of the *course*, whether the dogs catch their quarry or not. The course lasts from a few seconds to a few minutes. The winner is the dog that the judges decide did most towards catching the hare.

The rules of coursing were drawn up in England in the late 1500's, when coursing was a popular rural pastime. Coursing has always been extremely popular in Ireland. Many people and organizations oppose hare coursing as a cruel blood sport.

Court is a government institution that settles legal disputes and administers justice. Courts resolve conflicts involving individuals, organizations, and governments. Courts also decide the legal guilt or innocence of persons accused of crimes and sentence the guilty.

All courts are presided over by judges. These officials decide all questions of law, including what evidence is fair to use. In many cases, the judge also decides the truth or falsity of each side's claims. In other cases, a jury decides any questions of fact. The word *court* may refer to a judge alone or to a judge and jury acting together. It also may refer to the place where legal disputes are settled. To make sure cases are tried justly, courts normally sit in public, unless children or official secrets are involved.

Some court rulings affect only the persons involved in a case. Other decisions deal with broad public issues, such as freedom of the press, racial discrimination, and the rights of persons accused of a crime. In this way, the courts serve as a powerful means of social and political change.

Systems of law

The judicial systems of most countries are based on either *common law* or *civil law*. Some combine the features of both systems. This use of the term *civil law* refers to a legal system. It should not be confused with the

branch of law dealing with people's private relations with one another.

In common-law systems, judges base their decisions primarily on *precedents*, earlier court decisions in similar cases. Most English-speaking countries, including Australia, Ireland, New Zealand, the United Kingdom (excluding Scotland), and the United States, have common-law systems. Scotland has its own system of law, not based on common law. See *Scots law*.

Civil-law systems rely more strictly on written statutes (legislative acts). Judges may refer to precedents, but they must base every ruling on a particular statute and not on precedent alone. Most European, Latin-American, and Asian countries, and some African nations, have civil-law systems.

Civil-law and common-law countries generally have some courts that try only civil cases or only criminal cases, and some that try both kinds of cases. In communist countries, all courts have power to try both kinds of cases. Strict Islamic law did not distinguish between civil and criminal wrongs. But, today, most Muslim countries have separate civil and criminal courts.

Types of courts

Courts differ in their *jurisdiction* (authority to decide a case). Generally, courts are classified as *trial courts* or *appellate courts*, and as *criminal courts* or *civil courts*.

Trial and appellate courts. Nearly all legal cases begin in trial courts, also called *courts of original jurisdiction* or *courts of first instance*. These courts may have general jurisdiction or limited, also called *special*, jurisdiction. Courts of general jurisdiction hear many types of cases. The major trial court of any county, state, or other political unit is a court of general jurisdiction.

The losing side often has the right to *appeal*—that is, to ask that aspects of the case be reconsidered by a higher court called an appellate or *appeal court*. Most appeals are made on matters of law, but in some circumstances appeals may be made on the facts of a case.

Criminal and civil courts. Criminal courts deal with actions considered harmful to society, such as murder and robbery. In criminal cases, the state takes legal action against an individual. The sentences handed down by criminal courts range from probation and fines to imprisonment and, in some countries, death.

Civil courts settle disputes involving people's private relations with one another. Civil suits involve such non-criminal matters as contracts, family relationships, and accidental injuries. In most civil cases, an individual or organization sues another individual or organization. Civil decisions do not involve a prison sentence, though the party at fault may be ordered to pay damages.

Special courts and tribunals. Some courts have specialized jurisdiction, relating to the type of cases they hear or the category of offenders who appear before them. For instance, *juvenile courts* try offenders under a certain age, usually 16. *Family courts* hear cases concerned with divorce, custody of children, adoption, and other family matters. The *Maori Land Court* in New Zealand hears claims concerning Maori land or estates.

How courts work

How criminal courts work. Most persons arrested on suspicion of a crime appear before a judge called a



Courser is a swift-running desert bird found in Africa, India, and Australia. The Egyptian plover, above, is a courser that lives along the Nile River in Egypt.

magistrate within 24 hours after the arrest. In cases involving minor offences, the magistrate conducts a trial and sentences the guilty. In more serious cases, the magistrate decides whether to keep the *defendant* (accused person) in jail or to release him or her on bail. At this stage the defendant may also apply for, and be granted, *legal aid* (state funding for representation in court) if he or she cannot afford to pay for a lawyer.

Preliminary hearings or committal proceedings. In most countries, people accused of serious offences are first examined at a preliminary hearing to see whether there is a real possibility of convicting them. In Australia, England and Wales, and Northern Ireland, this hearing is conducted in open court by a magistrate. In New Zealand, it is conducted by a justice of the peace, and in the Republic of Ireland by a district judge. In Scotland, the case is considered by the procurator fiscal in private. In some states of the United States, the preliminary hearing is considered by a grand jury.

Trial. In most serious cases, under the common-law system, a defendant is entitled to a trial by jury. The jury decides the facts of the case and must be guided by the judge on the law, evidence, and procedure. The jury must decide if the evidence presented by the prosecution proves the defendant guilty "beyond reasonable doubt." If not, the defendant must be *acquitted* (found not guilty).

If the defendant is found guilty, the judge pronounces sentence. Convicted defendants may take their case to an appellate court. However, the constitution of most countries forbids the government to *put a person in double jeopardy* (try a person twice) for the same crime, although in some countries prosecutors may appeal against an acquittal.

How civil courts work. A civil action begins when an individual or organization, called the *plaintiff*, issues a *writ* against another individual or organization, called the *defendant*. The plaintiff formally states the injuries or losses he or she believes were caused by the defendant's actions in a document called a *statement of claim*. The plaintiff also asks for a certain amount of money in damages.

The defendant receives notice that a complaint has been filed and is directed to appear in court on a certain date. The defendant then files a document called a *defence*. The defence contains the defendant's version of the facts of the case and asks the court to dismiss the case. The defendant also may file a *counterclaim* against the plaintiff.

In most cases, the writ, the statement of claim, and the defence are the first of a series of documents called the *pleadings*. In the pleadings, the plaintiff and defendant state their own claims and challenge the claims of their opponents. Most civil cases are settled out of court on the basis of the pleadings. However, if serious questions of fact remain, a formal *discovery* takes place. This procedure forces each *litigant* (party involved in the case) to reveal evidence that would be introduced in court. If the case still remains in dispute after discovery, it goes to trial.

Civil cases are usually decided by a judge without a jury. The judge or jury determines who is at fault and how much must be paid in damages. The decision in civil cases is generally made on "a balance of probability";

in other words, whether it is more likely than not that the defendant did what the plaintiff alleges. After the decision, the losing side may appeal.

Courts in Muslim countries

The traditional law of Islam is called the *sharia*. The sharia derives from the Quran, the holy book of Islam (see *Quran*). The sharia consists of regulations concerning worship and ritual duties, and regulations concerning social behaviour. The regulations concerning social behaviour are what Europeans would call civil and criminal law. The courts that traditionally administer sharia law are called *sharia courts*. The judges in these courts are called *vadis*. In recent times, many Muslim countries have replaced the sharia courts with *secular* (nonreligious) courts modelled on European lines.

In some Muslim countries, religious courts still exist side by side with secular courts. The sharia courts have jurisdiction to deal with questions of personal status, such as marriage and divorce. The secular courts deal with most other matters. In Saudi Arabia, Islamic law is still the only law administered.

Courts in Communist countries

In Communist countries, courts are divided into three main groups: people's courts, regional courts, and supreme courts.

People's courts are the lowest courts. They are staffed by lay and professional judges. The lay judges are ordinary citizens who are elected to serve for short periods. The professional judges are lawyers who are elected annually.

Regional courts try the more serious civil and criminal cases. They also supervise the operation of the people's courts and hear appeals from them. When the regional courts act as appeal courts, they have professional judges. But when they act as courts of first instance, lay judges may take part.

Supreme courts are the highest courts in all communist countries. In a communist country, the supreme court is elected by the country's highest law-making assembly (see *Soviet*). The supreme court hears appeals from the lower courts, interprets the legal codes, and tries cases at first instance if they affect the welfare and security of the whole country. Each former Soviet republic has its own supreme court, which controls the lower courts and hears appeals from regional courts within the republic. The federal supreme court hears appeals from the supreme courts of the republics.

Special kinds of courts

Administrative tribunals. In many countries today, technical issues, concerning such things as trades and professions, government pensions, and licences to operate transport and other services, are enforced by administrative agencies and tribunals. These tribunals use simplified procedures, and do not have strict rules of evidence (see *Evidence*). They are staffed by judges who are experts in the various administrative fields. Some countries, such as Austria, Spain, and the United States, have passed administrative procedure codes to guarantee fair treatment of the public.

International courts. The International Court of Justice sits at The Hague, in The Netherlands. It is one of

the main organs of the United Nations. Judges from various associated countries staff this court. No country is bound to submit to this court unless it agrees to do so either generally or for a particular case, and the court has no means of enforcing its judgments against a country unless that country consents. See **International Court of Justice**.

In 1958, the European Economic Community (now known as the European Union, or EU) set up a court to interpret the laws and directives of the community. The court deals with all conflicts between EU laws and those of member states. See **European Union**.

History

Early courts. Tribal councils or groups of elders served as the first courts. They settled disputes on the basis of local custom. Later civilizations developed written legal codes. The need to interpret these codes and to apply them to specific situations resulted in the development of formal courts. For example, the ancient Hebrews had a supreme council, called the *Sanhedrin*, which interpreted Hebrew law.

The ancient Romans developed the first complete legal code as well as an advanced court system. After the collapse of the West Roman Empire in the A.D. 400's, the Roman judicial system gradually died out in western Europe. It was replaced by *feudal* courts, which were conducted by local lords. These courts had limited jurisdiction and decided cases on the basis of local customs.

Development of civil-law and common-law courts. During the early 1100's, universities in Italy began to train lawyers according to the principles of ancient Roman law. Roman law, which relied strictly on written codes, gradually replaced much of the feudal court system throughout continental Europe. In the early 1800's, the French ruler Napoleon I used Roman law as the foundation of the *Code Napoléon*. This code, a type of civil law, became the basis of the court system in most European and Latin-American countries.

By the 1200's, England had an established system of courts. These courts developed a body of law that was called *common law* because it applied uniformly to people everywhere in the country. Common-law courts followed traditional legal principles and based their decisions chiefly on precedents. English common law became the basis of the court system for most countries colonized by England, including Australia, India, Malaysia, New Zealand, and the United States.

Development of courts in Muslim countries. In many Muslim countries in the late 1800's, civil law and common law replaced Islamic law in various fields. Turkey, in the 1850's, and Egypt, in the 1870's, introduced commercial and criminal codes and new systems of courts, based on French models. In Anglo-Egyptian Sudan, which had many Muslim citizens, the British introduced criminal codes based on common law, and created new systems of courts that used the principles of common law and *equity*. But sharia courts survived in Sudan to decide family matters between Muslims. Tribal courts also survived. When the British ruled India, they introduced new courts that applied Islamic law to settle Muslim family affairs, and new civil and criminal codes for other cases. Turkey abolished the whole of the sharia and the sharia courts in 1926. Egypt and Tunisia abol-

ished them in the 1950's. According to traditional Islamic law, there was no system of appeal. But, today, most Muslim states allow appeals.

Related articles in World Book. For information on the courts of various countries, see the *Government* section of those articles. See also:

Officials			
Grand jury Judge	Jury Justice of the peace	Lawyer	
Procedures and documents			
Affidavit	Equity	Injunction	Subpoena
Appeal	Evidence	Inquest	Suit
Attachment	Fine	Mandamus	Summons
Bail	Forfeiture	Petition	Trial
Brief	Garnishment	Plea bargain-	Warrant
Class action	Habeas corpus	ing	Witness
Deposition	Indictment	Sentence	Writ
Other related articles			
Australia, Legal sys- tem of	International Court of Justice	Old Bailey	
Civil law	Juvenile court	Star Chamber	
Common law	Kangaroo court	United Kingdom,	
Court-martial	Law	Legal systems of the	

Court, Margaret Smith (1942-), an Australian tennis star, was rated among the world's top 10 female tennis players from 1961 to 1975, ranking number one seven times. Court was noted for her endurance and control, as well as her skill at blending power and delicacy in her shots.

In 1970, Court won the *grand slam* of tennis in singles competition—the Australian Open, the French Open, Wimbledon, and the United States Open. Only Maureen Connolly and Steffi Graf have also won the grand slam in singles. Court also won the grand slam in mixed doubles in 1963. Her career record of 64 titles in the four grand slam tournaments consisted of 24 in singles, 21 in women's doubles, and 19 in mixed doubles.

Margaret Smith was born in Albury, New South Wales. She married Barry Court in 1967. In 1977, she retired from tennis competition.

See also Tennis (Tables).

Court-martial decides legal cases relating to members of the armed services and civilians employed on military bases. Courts-martial follow normal legal methods. For example, prisoners are regarded as innocent until proved guilty, and are given full details of the charges laid against them. In more serious cases, prisoners are provided with a trained defence lawyer (often at no cost to themselves) and are given every opportunity to prepare their own cases.

In the United Kingdom, the United States, and most Commonwealth countries, officers commanding a company or larger group have delegated powers of *summary jurisdiction*. Commanding officers can, without a formal court-martial, deal with most minor offences committed by the junior ranks under their command. Punishment is normally a fine, loss of privileges, reduction in rank, or a short spell in the *guardroom* (local military prison). Such offences do not usually result in a *regimental entry* (permanent record) against the offender. A regimental entry might jeopardize the offender's later chances of promotion.

More serious offences are dealt with by a formal court-martial. In the United Kingdom and the United

States, many military cases are dealt with by special and district courts-martial comprising at least three officers. The most serious matters are referred to general courts-martial composed of at least five officers, assisted by a legal adviser who does not himself have a vote. In the United States, an enlisted man on trial may demand that at least one-third of the court be composed of enlisted men.

Most European countries include trained lawyers in their courts-martial. In Belgium and France, civilian judges control courts-martial. Most Commonwealth countries, including Australia, India, and New Zealand, follow a pattern similar to that in the UK. The Russian Federation has a three-level system of inferior, intermediate, and superior courts. Presidents and military judges are appointed from a cross-section of soldiers aged at least 25 and on active service.



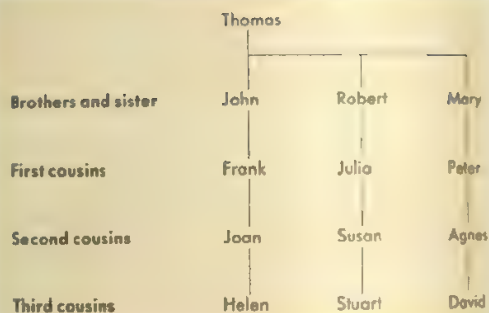
The Court of St. James's takes its name from St. James's Palace in London, above, formerly the sovereign's official residence.

Court of Saint James's is the title of the British royal court. It derives its name from St. James's Palace, in Westminster, London. The palace is no longer the monarch's residence, but ambassadors are still appointed "to the Court of St. James's," and the accession of every sovereign is publicly proclaimed from the palace balcony.

See also Saint James's Palace.

Courtship of Miles Standish, The. See Longfellow, Henry Wadsworth.

Cousin is a person outside your immediate family related to you by blood and descended from the same ancestor. The chart shows how cousins are related.



First cousins are children of brothers and sisters, and so Frank, Julia, and Peter are first cousins. *Second cousins* are children of second cousins, and so Joan, Susan, and Agnes are second cousins, and so on. A *first cousin once removed* is the child of your first cousin, so Susan and Agnes are Frank's first cousins once removed. Helen and Stuart are Peter's first cousins twice removed, and so on.

See also Family (Family relationships).

Cousteau, Jacques-Yves (1910–), is a French oceanographer, author, and film producer. He developed many techniques for undersea exploration. In 1943, Cousteau helped invent the *aqualung*. This breathing device enables a diver to move about freely under water for long periods. Cousteau also developed the first underwater diving station and an underwater observation vehicle called the *diving saucer*.

Since 1951, Cousteau has explored the oceans with his research ship *Calypso*. He has written books about sea life that have been translated into many languages. These books include *The Silent World* (1953), *The Living Sea* (1962), and *World Without Sun* (1964). He has produced many films about sea life, three of which won United States Academy Awards.

In 1960, Cousteau and Prince Rainier III of Monaco opposed France's plan to dump radioactive wastes into the Mediterranean Sea. France abandoned the plan that year. During the 1960's and 1970's, Cousteau's television series, "The Undersea World of Jacques Cousteau," dramatized underwater exploration and the need for conservation of ocean life. Cousteau was born in St.-André-de-Cubzac, near Bordeaux.

Couture, Thomas. See Painting (Realism; picture); Manet, Edouard.

Covenant, Ark of the. See Ark of the Covenant. **Covenanters** were Scottish Protestants who opposed Anglicanism and Roman Catholicism, and supported a Presbyterian system of church government. They became important in the late 1500's and 1600's. The Cove-



Jacques-Yves Cousteau



Covent Garden in London's West End attracts many tourists. The covered hall, *above*, is at the centre of Covent Garden and contains bars, market stalls, restaurants, and shops.

nanters received their name because they entered into agreements called *covenants* to defend and consolidate their faith.

The first covenant was signed in 1557, and a second covenant was declared in 1581 when Scottish leaders feared a revival of Roman Catholicism. When Charles I tried to compel Scotland to accept an Anglican prayer-book and *episcopacy* (church rule by bishops), the National Covenant (1638) united Scottish opposition. In 1639 and 1640, the king used military force in an attempt to destroy the Covenant. But Charles was defeated at the Battle of Newburn, in 1640.

In 1643, during the English Civil War, the Scottish General Assembly signed the Solemn League and Covenant with England's rebel Parliament. Parliament agreed to establish Presbyterianism in England. The Covenanters sent a powerful army against Charles, in return for a monthly payment of £30,000 from Parliament. Charles surrendered to the Covenanters in 1646, but they handed him over to the Parliamentary forces when he refused to accept the Covenant.

After the Restoration, in 1660, Charles II had some of the most influential Covenanters executed. He re-established episcopacy, and used soldiers to enforce it. The Covenanters' gatherings had to be secret, and soldiers often broke them up. In 1689, after William of Orange replaced the Roman Catholic James II and became William III, persecution of Covenanters ceased.

See also *Civil War, English; Scotland, History of*.

Covent Garden, in London, is the home of the Royal Opera House, one of the world's great opera houses. The Royal Opera House was opened in 1858 and stands on the site of two earlier theatres, the first of which opened in 1732. The permanent company at the theatre receives a grant from the Arts Council. See *Opera*.

Covent Garden was originally the site of the old *convent garden* of Westminster Abbey. The square known as *Covent Garden* was designed by Inigo Jones in the 1600's. St. Paul's, Covent Garden, a church designed by Jones, still stands. Residential housing was built up around the square in the 1600's. A small market began in the square in 1661. The market grew until special buildings had to be erected for it in the early and mid-1800's. In 1974, the market was moved to Nine Elms, in south London.

The old market area was redeveloped during the late 1970's to house an attractive shopping and tourist precinct. The new development opened in 1980. It attracts both tourists and residents to its craft shops, boutiques, restaurants, and wine bars.

See also *London*.

Coventry (pop. 292,600) is a city and local government district in West Midlands, England. For location, see *England* (political map). Coventry is an important industrial centre, and also the site of the Lady Godiva legend and of one of the world's most strikingly modern cathedrals. Products made in Coventry include aeroplane



Coventry is the site of two of England's best-known cathedrals. The medieval cathedral on the left was destroyed in 1940, during World War II. A striking modern cathedral was built to its right. The ruins of the original structure have been preserved as a memorial.

parts, bicycles, cars, textiles, and electrical and engineering goods

Coventry probably originated as a Saxon settlement in the AD 400s. Lady Godiva, who lived in the 1000s, rode naked through Coventry to get her husband—the city's ruler—to reduce heavy taxes. Lady Godiva and her husband are said to have founded a Benedictine monastery at Coventry on the ruins of a convent built in the 800s and destroyed by the Danes in 1016 (see *Godiva, Lady*). By the late 1300s, Coventry was a centre of textile manufacturing and watchmaking, and of *trade guilds* (organizations that protected and regulated trade).

In 1940, during World War II, German bombers destroyed most of central Coventry, including a 600-year-old Gothic cathedral. The area was rebuilt after the war. The rebuilding project included the construction of the city's famous modern cathedral. The new cathedral, which was completed in 1962, stands next to the ruins of the old one, now kept as a memorial. The new cathedral was designed by Sir Basil Spence. John Piper designed the stained-glass windows of the Baptistry, and Sir Jacob Epstein sculpted the magnificent figure of *St Michael Overcoming Evil* on the east wall.

See also *Cathedral* (picture: Coventry Cathedral).

Coverdale, Miles (1488-1568), a bishop of Exeter, England, became famous for his English translation of the Bible in 1535. He used Tyndale's English version of the New Testament and parts of the Old Testament. He translated other portions from the Latin and from Martin Luther's German translation. Coverdale also helped produce the Bible of Cromwell, also called the *Great Bible*, and edited Cranmer's Bible. He was born in North Yorkshire, England, and educated at Cambridge University.

Cow is a female adult animal of the bovine group. The term *cow* is also used for the female of other mammals, including moose and seals. Cows, bulls, and steers are called *cattle* (see *Cattle*).

Cow parsnip is a large, coarse North American plant, closely related to the hogweeds of Europe and Asia. It grows from 1.2 to 2.4 metres high and has large, hairy leaves. Its small white flowers grow in huge clusters. The plant becomes a troublesome weed when allowed to grow in damp soil near water. The cow parsnip may be eaten in place of celery, but is usually used as fodder.

See also *Hogweed*.

Scientific classification. The cow parsnip belongs to the parsley family, Umbelliferae (Apiaceae). It is *Heracleum maximum*.

Coward, Sir Noel (1899-1973), a British playwright, actor, and composer, became famous for his witty, sophisticated comedies. Many of his plays deal with romantic conflicts between upper-class men and women.

Coward's most popular comedies include *Hay Fever* (1925), *Private Lives* (1930), *Design for Living* (1933), and *Blithe Spirit* (1941). He also wrote *Tonight at 8:30* (1936), a collection of nine one-act plays designed to be performed in groups of three. Coward composed a number of musicals, the best known of which is the operetta *Bitter Sweet* (1929).

Coward wrote two autobiographical books, *Present Indicative* (1937) and *Future Indefinite* (1954). *The Noel Coward Diaries* was published in 1982, after his death. He also wrote a novel, *Pomp and Circumstance* (1960), and short stories, many published in *The Collected Sto-*

ries of Noel Coward (1963). Coward also wrote, co-directed, and starred in the film *In Which We Serve* (1942).

Noel Pierce Coward was born in Teddington, near London. His first major success came in 1923 as part author and star of the musical revue *London Calling*. In 1924, Coward won acclaim for his play *The Vortex*, which deals with the moral decline of the British upper class after World War I (1914-1918). Queen Elizabeth II knighted Coward in 1970.

Cowbird is the name of a group of birds found in North America and South America. The *brown-headed cowbird* lives from southern Canada to Mexico. The male brown-headed cowbird is about 20 centimetres long. It has a brown head and a shiny black body. The smaller female is brownish-grey.

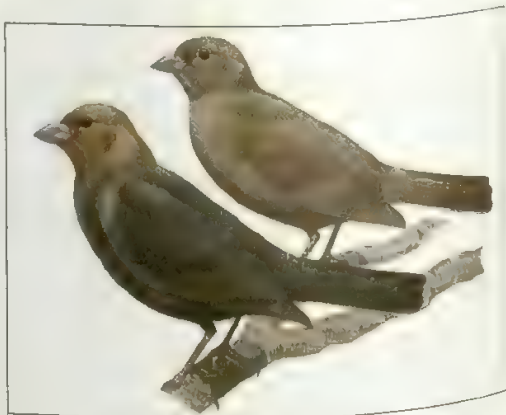
Brown-headed cowbirds lay their eggs in the nests of other birds, leaving the young for the foster parents to raise. The female cowbird chooses a nest that belongs to some smaller birds and lays an egg in it while the owners are away. She then flies off and does not return. The young cowbird is much larger than the other young birds in the nest and usually gets most of the food. As a result, the other nestlings sometimes starve. The foster parents do not seem to realize that they are raising an outsider. But if the egg is discovered, the nest owner may not allow it to hatch. For example, a yellow warbler may cover the egg and build another nest on top of the old one. The eggs of the brown-headed cowbird are white with brown specks.

Several other species of cowbirds are found in the Americas. Almost all of them, like the brown-headed cowbird, lay their eggs in the nests of other birds. Cowbirds feed on insects, worms, seeds, and berries.

Scientific classification. Cowbirds belong to the emberizid family, Emberizidae. The brown-headed cowbird is *Molothrus ater*.



Sir Noel Coward



Brown-headed cowbirds range from Canada to Mexico. The female, right, is smaller than the male, left.



Detail from *Trail Herd* by H. V. Johnston, 1871, an oil painting on canvas by W. H. H. Loomer. Buffalo Bill Herd of 1871, 1871, Wyoming, U.S.A.

The **trail drive** moved large herds of cattle great distances from ranches to a railway station for shipment to markets. Cowboys rode ahead, behind, and at each side of the plodding herd. A trail drive lasted from two to three months.

Cowboy

Cowboy is a person who helps take care of a large herd of cattle for a ranch owner. In the United States, cowboys won fame in the days of the Western frontier. Their reputation for bravely facing danger and hardship made them heroes to many Americans. Exciting tales of cowboy life, sad cowboy songs, and colourful cowboy language have all become part of American folklore. Many of the most popular novels, motion pictures, and television shows have been about cowboys.

Christopher Columbus took cattle to America on his second voyage in 1493. The Spanish also introduced cattle into Mexico in the 1500's. Spanish cattle made their way into Texas by the early 1700's. Spanish methods of handling cattle on horseback entered the American colonies in the 1800's.

The height of the cowboy period lasted only about 20 years, from the mid-1860's to the mid-1880's. During that time, cowboys riding on horseback tended great herds of cattle on vast stretches of unfenced land called the *open range*. They also took cattle on *long trail drives*. Trail drives were the cheapest way to move cattle from Western ranches to railway stations for shipment to Eastern markets. But by 1890, far fewer cowboys were needed. The use of fences and the spread of farms had put an end to the open range, and expansion of the railways had done away with the long trail drives.

There have probably never been more than 100,000 cowboys in the United States. But cowboys achieved an importance far beyond their numbers. Hard-working cowboys helped make the West a productive part of the United States. In the process, they came to stand for the

frontier spirit of courage, independence, and self-reliance. Today, the life of a cowboy on the old frontier might seem glamorous and exciting. But cowboys found it difficult, dangerous, and—at times—even dull.

Cowboys were sometimes called *cowpokes* or *cow punchers* because they used sticks to poke cattle onto loading ramps. Cowboys call all cattle *cows*, even bulls and calves.

Most countries with cattle ranches have cowboys. This article deals chiefly with the height of the cowboy period in the United States. For a description of the life of a modern American cowboy, see *Ranching*.

A cowboy's equipment

American cowboys copied much of the equipment used by Mexican cowboys, who are called *vaqueros*. The big sombrero worn by *vaqueros* became an American cowboy hat. *La reata*, the rope in Spanish, became the *lariat* used by cowboys to rope cattle. Even the word *vaquero* became *buckaroo*, another English word for cowboy.

His clothing served a useful purpose. A cowboy hat, for example, had a wide brim to keep rain, snow, and sun off the cowboy's face. The air space in the hat's deep crown kept the cowboy's head cool. A cowboy also used his hat to fan a fire, to signal to other cowboys, and to scoop up water from a stream.

A coat got in a cowboy's way, and so he wore one only in bitter cold weather. Most cowboys wore a waistcoat over their shirt instead of a coat. The waistcoat had pockets to hold such items as a watch, tobacco, and a few coins.

A cowboy wore seatless leather trousers called *chaps* over his regular trousers. Chaps protected his legs from

thorny brush and from rubbing during long hours in the saddle. Chaps were adapted from the trousers, called *chaparajos*, worn by vaqueros.

Cowboy boots had high, tapered heels. The heels kept a horseback rider's feet from slipping through the stirrups. Their tapered shape prevented a cowboy's foot from catching in a stirrup if he fell from his horse. A cowboy who fell or got thrown would be dragged along the ground if he could not get free of the stirrup.

The spurs that cowboys fastened to the heels of their boots helped them control a horse. Each spur had a small spiked wheel at the back called a *rowel*. When a horse did something wrong, the cowboy pressed the rowel against the horse's side.

The bandanna, or neckerchief, a cowboy tied around his neck could be pulled over his nose on a dry, dusty trail or during a dust storm. Leather gloves protected a cowboy's hands from rope burns.

His horse. Cowboys spent most of their working hours in the saddle. Horses not only enabled cowboys to cover great distances but also helped them control the cattle. Few cowboys owned their own horse. Most cowboys rode horses that belonged to the ranch owner. Each cowboy had a string of horses assigned to him. Because a cowboy changed mounts frequently, he did not have a favourite horse that he loved above all others.

Cowboys rode horses called *mustangs* or *broncos*. Mustangs were descended from horses that Spanish explorers took to North America in the 1500's. Some of the Spanish horses escaped, ran loose, and multiplied. By the mid-1800's, bands of mustangs roamed the Great Plains and Rocky Mountains. These small, swift horses made excellent "cow ponies." They had great strength, and they seemed to sense what a cow would do next.

Mustangs had to be tamed before cowboys could ride them. A wild horse would leap, kick, and twist to remove anything on its back. To *break* (tame) a mustang, a cowboy had to get on its back and whip the animal each time it bucked. Most mustangs soon learned that disobedience meant pain and thus began to obey the cowboy. But a few horses could never be broken. Cowboys who cured mustangs of bucking were often called *broncobusters*. In time, mustangs were bred with other horses to produce a larger and less wild animal.

His rope, or lariat, was a cowboy's most important tool. One end of the lariat was knotted to form a small eye, called a *honda*. The other end of the rope slipped through the honda to form a large, adjustable loop. A cowboy kept a coiled lariat hanging from his saddle. Every cowboy had to know how to rope cattle. Cowboys also used a lariat to pull cattle out of the mud, to tie up horses, and to drag wood to a campfire.

Cowboys adopted the roping techniques of the Mexican vaqueros. A skilled roper knew exactly when and how far to toss a lariat to catch the neck, horns, or legs of a running cow. He could then throw a 450-kilogram animal to the ground. To rope a cow, a cowboy on horseback wrapped the end of his lariat around his saddle horn. He whirled the loop overhead and then tossed it in front of the cow's onrushing feet or over its head. The cowboy's horse then stopped dead, the loop tightened, and the cow fell to the ground.

His saddle was a cowboy's most prized possession. Every cowboy owned a saddle, even though few cow-



Through the Alkali (1904), an oil painting on canvas by C. M. Russell; The Thorne Gilcrease Institute of American History and Art, Tulsa, Oklahoma, U.S.A.

A cowboy on horseback used equipment and skills borrowed from Mexican cowboys, called *vaqueros*. Cowboys copied the hat, chaps, saddle, lariat, and roping techniques of the vaqueros.

boys owned a horse. A saddle had to be well made to hold up under constant use, and a cowboy selected his saddle carefully. A cowboy who had to sell his saddle was totally penniless and down on his luck.

The saddle used by cowboys was adapted from that of the vaqueros. It had a large horn in front, to which the cowboy attached his lariat when roping cattle. The high *cantle* (back of the saddle) supported the cowboy's lower back and made all-day rides more comfortable.

His gun, in most cases, was a revolver with six chambers known as a *six-shooter*. Most of the time, however, a cowboy did not carry his gun. A gun was a nuisance to a man on horseback. It added extra weight and got in the way. Besides, few cowboys had much money to spend on bullets for practice, and a cowboy needed practice to become a good shot. But most cowboys liked to put on a gun to look impressive when they went into town. On a trail drive, a cowboy kept a gun tucked in his bedroll. A gun was useful for killing rattlesnakes, shooting a horse with a broken leg, and turning back stampeding cattle.

The life of a cowboy

A cowboy's life was filled with hard work, danger, and loneliness. Tending cattle was hard because the animals got into trouble so often. Cowboys had to pull cattle from quicksand, ease them out of barbed wire fences, and drag them from mud. They also had to nurse sick and injured cattle and help cows as they gave birth.

Each day, a cowboy faced the risk of broken bones, crippling accidents, and even death. Very few ranches were near a town with a doctor, and so cowboys treated themselves most of the time. Untamed horses often threw riders, and a bad fall could easily break a

man's leg. A broken bone that was improperly set could leave a cowboy crippled for life. Even roping could mean the loss of a finger or two if the cowboy's hand got caught between the rope and the saddle horn. A kick from a horse could kill a cowboy. And a vicious horse might kill a rider by racing under a low branch. A cowboy could be trampled to death in a stampede.

In general, cowboys led a lonely life. Most ranches lay far from even the smallest town. A cowboy could go for weeks without seeing anyone but the few hands he worked with. Two events broke the monotony of a cowboy's life on the ranch—the roundup and the trail drive.

On the ranch, a cowboy's main job was to watch and protect the cattle as they grazed on the range. Cowboys also had to repair bridles, harnesses, and other equipment. The cattle the cowboys first tended were *Texas longhorns*. The cattle were named after their long horns, which had an average spread of about 1.2 metres. Like mustangs, Texas longhorns were descended from Span-

ish animals that had broken loose and multiplied. When early settlers from the East moved to the West, they found longhorn meat to be tough and stringy. They eventually bred longhorns with their Eastern stock to produce more tender meat.

On large ranches, cowboys slept in a bunkhouse apart from the ranch owner's house. A bunkhouse had few comforts. Rows of bunks stood along the walls. Pegs on the wall held clothing and other equipment. Most cowboys went to bed early, exhausted from the day's work.

Before barbed wire fences came into use, cattle roamed freely on the open range. They could wander long distances in any direction. For this reason, small outposts called *line camps* stood near the boundaries of a ranch. Cowboys called *line riders* worked out of the camps. Each rider patrolled a certain area, watching for sick or stray cattle and for signs of cattle rustlers.

Barbed wire came into use in the mid-1870's. Cowboys then had the tough job of building fences. They had to dig the postholes by hand and tightly string the wire with its many sharp points from post to post. The line riders became *fence riders*. A fence rider had to spot tears in the barbed wire and mend them. On many ranches, windmills pumped water for the cattle. When the windmills broke down, cowboys had to fix them.

Cowboys worked almost every day, from sunrise to sunset. Few cowboys got to town more than once a month, usually on payday. In town, a cowboy might drink and gamble away his pay in a saloon or gambling hall. Sometimes, a cowboy drank too much and walked down the street shooting his gun into the air. As a result, he landed in jail for the night and had to pay a fine the next morning. But most towns were not too hard on cowboys. They did not want to lose their business.

The roundup took place each spring and autumn. A roundup was necessary to identify and brand newborn calves. A calf received the brand of its mother. Each ranch had its own brand, which it placed in a certain position on all its cattle. For example, a brand might be de-



Roping cattle was a skill every cowboy needed. A cowboy kept a coiled lariat hanging from his saddle. He knew exactly how to toss the lariat to catch a running animal's legs, head, or horns.



Branding took place during the roundup. After cowboys had rounded up the cattle, they gave each calf the brand of its mother. Branding served to identify cattle in the days of the open range, when animals could wander great distances over unfenced land.



A **chuck wagon** carried food, cooking utensils, drinking water, and the cowboys' bedrolls during the trail drive. After the cattle settled down for the night, the cowboys gathered around the wagon to eat. Chuck wagons were also used on the range during roundups.

scribed as a *cloverleaf* placed *right side, flank*; or the letter *R* placed *left side, jaw*. Cattle owners registered their brands with local officials.

Branding showed who owned an animal. It made recovering lost or stolen cattle easier. In the days of the open range, a cow could wander all the way from Texas to Montana. Anyone who found the stray could check to see whose brand it bore and then arrange to return the cow to its owner. Sometimes, a rancher would try to alter the brands on stray animals so that the strays appeared to bear his brand. In most cases, people caught changing a brand met with swift and stern justice.

In the days of the open range, cattle from several ranches in a region grazed together and so became mixed. At roundup time, cowboys from all the ranches worked together to bring in the cattle. Crews of cowboys scattered over the range. They searched for cattle and drove them to a central point.

After the cowboys had rounded up all the cattle, men from each ranch sorted out their cattle according to brand. They then separated the newborn calves from their mothers for branding. At the autumn roundup, they also selected the cattle to be sold for beef. Cowboys rode well-trained *cutting horses* among the cattle to edge out, or *cut*, an animal from the herd.

After a cowboy cut a calf out, he drove it to a fire, where branding irons were kept red hot. The cowboy pressed an iron against the calf. The burn that resulted left a permanent scar. Another cowboy kept count of all the calves that were branded so the cattle owner would know how many cattle remained after those to be marketed had been cut out. Cowboys might also make a knife cut in a cow's ear for extra identification. When cattle were bunched together, it was hard to read their brands. But a cowboy could easily see an earmark.

After work each day at roundup time, cowboys from all the ranches got together to sing, tell tall tales, and swap gossip. At the end of most roundups, cowboys

competed against one another to determine the best rider, roper, and broncobuster. The competition became known as a *rodeo*, the Spanish word for *roundup*.

The **trail drive** was a major event in a cowboy's life. A trail drive usually lasted about two or three months and covered as much as 1,600 kilometres. During the long drive, cowboys moved from two thousand to three thousand cattle to a railway station for shipment to market. They worked long days and sometimes through part of the night.

Before the trail drive began, cowboys collected cattle from several ranches and turned them over to a *trail boss* employed by the ranch owners. The trail boss hired 10 to 12 cowboys to handle the herd during the drive. He also hired a *wrangler* and a cook. The wrangler looked after the 50 or more horses needed on the drive. Most wranglers were young and inexperienced.

The cook got the *chuck wagon* ready for the trail drive while the cowboys were busy during the roundup. This large covered wagon had to carry enough food for the cowboys during the long drive. It also carried cooking utensils, drinking water, and the cowboys' bedrolls.

The tough, hardy longhorns were ideal for trail driving. They ate almost any kind of plant, and their long legs and big hoofs enabled them to travel great distances. Heat and hunger did not seem to affect them. Above all, longhorns could travel as long as three or four days between drinks of water.

During the trail drive, the cowboys had to keep the cattle together and headed in the right direction. They rode ahead, behind, and on each side of the herd. Cattle sometimes panicked when crossing a river and began swimming in circles. Thunderstorms or any other sudden noise could frighten jittery cattle into stampeding. To stop a stampede, the cowboys would race in front of the herd. They would then wave their hats and fire their guns in the air to turn back the lead cattle.

The drive stopped each day just before sunset, and

the cattle grazed for a while. The cowboys then herded them into a tighter group that was easier to control at night. Cowboys took turns watching the herd through the night. They often sang as they circled the herd because they thought their singing kept the cattle calm.

The cowboys ate after the cattle had settled down for the night. Their meals on the drive consisted mainly of beans, bacon, and bread rolls. A cowboy slept next to a saddled horse so that he could jump into the saddle if the cattle stampeded during the night.

At the end of the trail drive, the cowboys arrived in a *cow town*, where the cattle were sold and loaded on a train. A cowboy usually wanted a shave and a haircut first and then a bath and clean clothes. Next, he wanted a good meal. After that, he was ready to celebrate in the nearest saloon. Cowboys received their wages at the end of the trail drive. Most of them spent their pay in a few days and then headed back to the ranch.

History

The growth of the American cattle industry made cowboys necessary. Raising cattle became an important business in Texas after the American Civil War ended in 1865. A cow cost from \$4 to \$5 in Texas, and millions of them roamed the open range. At the same time, Easterners wanted beef and were willing to pay from \$40 to \$50 a head. Texas cattle owners, seeing the big profits to be made, hired cowboys to drive cattle northward to the nearest railroad station for shipment to the East.

In 1866, cowboys drove thousands of cattle to the railroad station in Sedalia, Missouri, in the first major trail drive. But farmers along the way objected to cattle trampling their fields. A few angry farmers with shotguns convinced cattle ranchers to find another route.

In 1867, the Union Pacific Railroad reached Abilene, Kansas, which lay west of farming country. That year, the Chisholm Trail opened. It ran about 1,600 kilometres from southern Texas to Abilene. The Western Trail opened in 1876, after farmers settled beyond Abilene. It ended west of Abilene, in Dodge City, Kansas. Abilene and Dodge City boomed as cow towns.

Cowboys got their start in Texas. By 1870, ranchers had discovered that cattle could survive the cold winters in the northern Great Plains. Ranches sprang up in what are now Montana, Wyoming, Colorado, and the Dakotas, which had almost no settlers at that time. Trail drives were used to stock northern ranches with cattle. Cowboys moved north with the cattle.

By the late 1880s the open range was nearly gone. The invention of barbed wire made it possible to fence off individual ranches. Railroads extended all the way to the West Coast. Thus, the roundup and the long trail drive were no longer needed. Towns grew quieter as churches and schools began to outnumber saloons and gambling halls. The Wild West had been tamed.

The early cowboys. Frontiersmen who had moved to the American West became the first cowboys. They felt at home in the outdoors and already knew how to ride. Probably nearly a fourth of all cowboys were blacks, and another fourth were Mexicans. Many of the black cowboys moved to the Western frontier after the American Civil War. Others had been slaves on Texas ranches before the war. Many of the Mexican cowboys had remained in Texas after Texas declared its inde-

pendence from Mexico in 1836. A sense of equality developed among cowboys because of the hard work and danger they shared. But black cowhands had difficulty finding jobs after the open range ended and jobs on ranches became scarce.

Most Westerners looked down on cowboys. They viewed cowboys as rough, rude, and uncivilized. But writers in the Eastern states made cowboys seem like heroes. Books, magazines, and newspapers told of the cloudless blue skies and unlimited open prairie in the West and of brave young cowboys who performed difficult and daring feats. Soon, many young men in the East wanted to sleep under the Western stars. They headed west by train or stagecoach to become cowboys.

Cowhands today continue to work on ranches and tend cattle, in the U.S.A. and elsewhere. They still must know how to rope and ride and be able to work long hours in any kind of weather. But they use machines for many jobs, such as digging holes for fence posts. Modern cowboys transport cattle by truck and use helicopters to search for stray cattle. The spirit of the hard-riding cowboy is kept alive by the rodeo. The modern rodeo show is a big money sport, watched by millions of spectators every year. The rider who wins the most prize money in a season is named World Champion All-Around Cowboy. A number of ordinary cowhands have become rich and famous riding in the rodeo.

Cowboy Hall of Fame. The National Cowboy Hall of Fame and Western Heritage Centre opened in Oklahoma City, Oklahoma, in 1965. It honours outstanding Americans who helped develop the West. The institution is sponsored by 17 Western states. It includes an art gallery of Western photographs, paintings, and sculptures; a reconstructed Western town; the Rodeo Hall of Fame; and a library of Western history.

Related articles in *World Book* include:

Bronco	Horse
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Gaucha	Rodeo
	Saddle
	Westward movement

Outline

I. A cowboy's equipment

- His clothing
- His horse
- His rope
- His saddle
- His gun

II. The life of a cowboy

- On the ranch
- The roundup
- The trail drive

III. History

Questions

- How did cowboys brand cattle?
Where did the Chisholm Trail run?
What was a line rider's job?
Why did the cattle industry become important in Texas?
What are some items of cowboy clothing? How were they useful to a cowboy?
What purpose did a trail drive serve?
Why were cowboys also called *cowpokes* or *cowpunchers*?
What did it mean when a cowboy had to sell his saddle?
Why were roundups necessary?
What put an end to the open range?

Cowen, Sir Zelman

(1919-), a distinguished Australian lawyer, was governor-general of Australia from 1977 to 1982. He was born in Melbourne and educated at Scotch College and Melbourne University. In 1940, he was elected Rhodes scholar for Victoria and, following naval service during World War II, went to Oxford University, England, in 1945. He was a fellow of Oriel College, Oxford, from 1947 to 1950. He was professor of public law at Melbourne University from 1951 to 1966. He served as vice chancellor of the University of New England in Armidale, New South Wales, from 1967 to 1969 and of the University of Queensland, at Brisbane, from 1970 to 1977. He was chairman of the United Kingdom Press Council from 1983 to 1988. He served as provost of Oriel College from 1982 to 1990.



Sir Zelman Cowen

Cowes is a well-known yachting centre on the north coast of the Isle of Wight, England. The town, in the local government district of Medina, is situated on both sides of the mouth of the River Medina. It overlooks the Solent. Cowes includes the former towns of West Cowes and East Cowes. It lies about 16 kilometres south of Portsmouth and is a fashionable resort.

Osborne House was built in 1845 at East Cowes for Queen Victoria. At West Cowes, the former Cowes Castle, built by Henry VIII, is the headquarters of the Royal Yacht Squadron, a club established in 1815. *Cowes Week* is an annual yachting regatta. See also **Wight**, Isle of and **Medina**.

Cowley, Abraham (1618-1667), was an English poet and essayist whose first volume of verse was published when he was 15. His major publications include *Poetical Blossoms* (1633), *The Mistress* (1647), and his unfinished epic, *Davidis* (1656). Cowley began as a rather derivative, mechanical love poet, strongly influenced by poet John Donne and his followers. Later, Cowley began to write *Odes* in the manner of the Greek poet Pindar. This new style produced his best poem, "Ode to the Royal Society." Samuel Johnson published a famous attack on the metaphysical poets in his *Life of Cowley* (1779).

Cowley was born in London. As a follower of Charles II, he served the royalist cause in exile during the Puritan revolution. He returned to favour after the Restoration in 1660. That year, Cowley helped form the Royal Society, an organization that promotes the natural sciences.

See also **Metaphysical poets**.

Cowpea, also known as *black-eyed pea* or *black-eyed bean*, is a popular plant that grows in warm climates. In Southeast Asia, a climbing form of the plant is grown for its edible seed pods. In the West Indies and West Africa, a short, erect form of the plant is grown for its seeds, which form the main ingredient of soups and stews. In the Southern United States, the cowpea is grown mainly as feed for animals and as a fertilizer. The cowpea contains a high level of protein.

Scientific classification. The cowpea belongs to the pea family, Leguminosae (Fabaceae). It is *Vigna sinensis*.

Cowper, William (1731-1800), was an English poet. He wrote simple poems about nature and rural domestic life. These poems became forerunners of the works of the English romantic poets of the early 1800s.

Cowper was born in Hertfordshire, near London. He studied law, and was *admitted to the bar* (became a barrister) in 1754. But he did not like law and never practised. A shy, gentle man, he suffered fits of melancholy that were perhaps intensified by his devotion to strict Calvinistic religious beliefs. Frequent attacks of spiritual despair led to recurrent periods of insanity and two suicide attempts.

During his healthy periods, Cowper wrote many great hymns. The *Olney Hymns* (1779), written with John Newton, a minister, includes the famous "Oh! for a Closer Walk with God" and "God Moves in a Mysterious Way."

Much of the charm of Cowper's poetry comes from his gracious, kindly personality. Cowper also had a good sense of humour. His comic masterpiece is the merry ballad "The Diverting History of John Gilpin" (1782). Cowper was angered by the inhumanity shown in people's dealings with one another. "Minds are never to be sold" he declared in his antislavery poem, "The Negro's Complaint." Typically, however, Cowper wrote quiet, descriptive, thoughtful poems about nature and everyday life. He liked tame, not wild nature. "Yardley Oak" (1791) does not describe the ancient oak but the nostalgic feelings it arouses in the poet. Cowper's last poem, "The Castaway" (1799), powerfully evokes feelings of despair.

Cowper's major work was a 5,000-line poem called *The Task* (1785). This long, rambling poem was written in blank verse. It describes familiar rural sights and events—for example, a team of horses travelling through a snowstorm, the arrival of the mail, and the countryside in the evening. The poem shows Cowper's love of the country and his distaste for city life.

See also **Literature for children** (The rise of illustration).

Cowpox. See **Jenner, Edward**.

Cowrie, also spelled *cowry*, is a sea snail with a shiny, colourful shell. It lives in the shallow waters of warm seas. Cowries may be from 1.5 to 15 centimetres long. The top of the shell looks like a colourful egg, and the underside has a long, narrow opening bordered by many small teeth. There are more than 200 kinds of cowries. Most cowries feed on algae. Some feed on sponges, and some on both plant material and small marine animals. Some kinds are extremely rare and are worth great sums of money to shell collectors. Cowries were once used as money in China, India, and Africa. One kind was worn as a badge of office by chieftains in the Fiji Islands. See **Shell**.

Scientific classification. Cowries belong to the cowrie family, Cypræidae.

Cowslip is an attractive plant that blooms in the spring. The flower head, known as an *umbel*, is made up of individual flowers that look like miniature primroses. The flowers, which are deep yellow, and orange at the base, are fragrant.

The cowslip is a European plant found in grassland areas and hedgerow banks. In the United Kingdom, many cowslips have been dug up to put in people's gardens. This activity is now illegal. See also **Primrose**.

Another plant also called cowslip is the North Amer-



Cowslip is a spring flower that grows in fields and on grassy banks, especially on chalk or limestone soils.

ican Virginia cowslip. The Virginia cowslip has blue trumpetlike flowers which are pink in bud.

Scientific classification. The European cowslip belongs to the primrose family, Primulaceae. It is *Primula veris*. The Virginia cowslip belongs to the borage family, Boraginaceae. It is *Mertensia virginica*.

Cox, William (1764-1837), was a pioneer settler in Australia. In 1815, he completed the first road across the Blue Mountains, in New South Wales. The road, which took less than six months to build, ran for 163 kilometres from the Nepean River to the Macquarie River. Cox was born at Wimborne Minster, Dorset, England. He entered the Army in 1797, and went to Australia.

Coyote is a wild member of the dog family. It is known for its eerie howl, usually heard during the evening, night, or early morning.

Coyotes once lived only in western North America. However, they now inhabit much of the United States, Canada, and Mexico, and even parts of Central America. The coyote lives in a variety of environments, including

deserts, mountains, and prairies. It is sometimes called the *prairie wolf* or *brush wolf*.

Adult coyotes vary in colour from light yellow or yellowish-grey to brownish-yellow. Their fur may be tipped with black. The coyote has large, pointed ears and a bushy tail. An adult coyote measures about 1.2 metres long, including its 28- to 40-centimetre tail. It stands just over 0.5 metre high and weighs from 11 to 14 kilograms. Most coyotes live alone or in pairs, but some form groups of three or more.

Most female coyotes first mate when they are about 2 years old. They have a pregnancy period of 60 to 63 days. In spring, the female usually gives birth to five or six pups. A newborn coyote weighs from 200 to 275 grams. It is born blind, but its eyes open within two weeks. The mother provides milk for her young until they are 6 or 7 weeks old. By that time, the pups have



The coyote lives in most areas of the United States, Canada, and Mexico and in some parts of Central America. Unlike most animals, the coyote has expanded its range through the years.

begun to eat prey and other foods supplied by their parents. Most coyote pups can care for themselves by late summer, when they leave the parents.

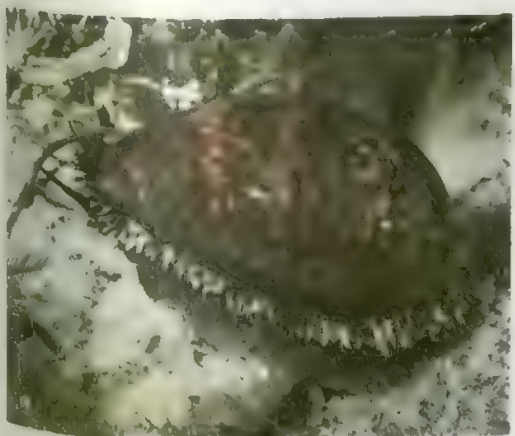
Coyotes feed on a wide range of animal and plant food. They feed chiefly on rabbits, and rodents such as ground squirrels, mice, and rats. They also eat ground nesting birds, reptiles, insects, berries, and fruits. In winter, coyotes in northern regions feed on the remains of large dead animals such as deer.

Some ranchers dislike coyotes because the animals kill cattle, sheep, and other livestock. Other people, however, think coyotes help keep rodent populations under control and are valuable for that reason.

Scientific classification. The coyote belongs to the dog and wolf family, Canidae. It is *Canis latrans*.

Coypu. See Nutria.

Coysevox, Antoine (1640-1720), was the leading French sculptor during the latter part of the reign of Louis XIV. Coysevox produced much of the sculpture that decorated the gardens and palace of Versailles. Much of his work reflected the tastes of Louis XIV.



A cowrie has a glossy, richly coloured shell. Cowries live in the shallow parts of warm seas. Some types of rare cowries are highly prized by shell collectors.

Its rich, ornamental style reflects a desire for dignity and grandeur.

Coysevox also made many portrait busts. Several of those he did later in his career are more informal and lively than his earlier decorative sculpture. This informality reflected the developing taste of the 1700's. Coysevox was born in Lyon. A picture of his statue *Mercury* appears in the **Sculpture** article.

Cozzens, James Gould (1903-1978), an American author, became best known for his novels of upper-class manners. Cozzens' fiction shows his fascination with social roles and social codes and forms. The typical Cozzens hero is a professional man who distrusts emotion and believes in reason and self-discipline. Cozzens' style is analytical and filled with realistic detail.

Cozzens won the 1949 Pulitzer Prize for fiction for his novel *Guard of Honour* (1948), which concerns military life on an Air Force base. Cozzens' most popular novel is *By Love Possessed* (1957). The work investigates how a lawyer's life and principles are shaken by discoveries he makes about his friends and family. *Men and Brethren* (1936) is a study of a liberal clergyman. *The Just and the Unjust* (1942) describes the impact of a murder trial on the various participants.

Cozzens was born in Chicago, Illinois. He wrote his first novel in 1924, but his first notable work was the novelette *S.S. San Pedro* (1931).

CPR. See **Cardiopulmonary resuscitation**.

Crab is an animal that is covered by a hard shell, and that has jointed legs. It lives in shallow waters along the shore, and also in deep waters. Many kinds are valued as food. There are about 4,500 different kinds. Some kinds, such as fiddler crabs, live in burrows in the banks of salty tidal streams. Some other kinds of crabs live in fresh water or in burrows up to several kilometres inland. Some crabs live among corals, while others are deep-sea dwellers.

The smallest crabs are the tiny pea crabs. The female pea crabs live in the sheltering shells of live oysters. The shape and relative size of the big claws of crabs differ greatly among the species, according to their habits. Male fiddler crabs have one pincer much larger than the other. Hermit crabs live in empty sea shells and close them tightly, using one claw as a door. The colour, form, and texture of claws, legs, and bodies run through many shades and shapes, and from smooth to rough and spiny. Some crabs are swimmers, and have paddles on the last pair of legs. Many crabs run sideways on the sand or rocks of the seashore. Swimming crabs have paddlelike extensions on their legs. Crabs eat other small crustaceans and organic matter.

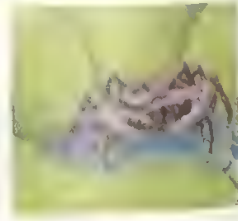
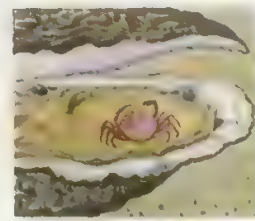
Edible crabs. The European *edible crab* has a large shell with a pie-crust pattern. The *blue crab* is the most common crab sold as food in eastern North American markets. In the Indo-Pacific region, several species are caught for food. One of the most popular is the *blue swimming crab*, which is also found in Australian waters. Apart from the blue swimming crab, Australians also fish commercially for the *mud* or *mangrove crab*, a heavy-bodied species with a spiny shell. The *Japanese spider crab* is fished extensively in the Far East.

Scientific classification. Crabs are in the phylum Arthropoda, class Crustacea, order Decapoda. The European edible crab is *Cancer pagurus*; the American blue crab is *Callinectes*

Some kinds of crabs



Crabs make up part of the animal life along many seashores. The ghost crab, *left*, lives in burrows on sandy beaches. Its colour blends so well with sand that a motionless ghost crab seems to disappear. The rock crab, *right*, dwells on rocky seashores.



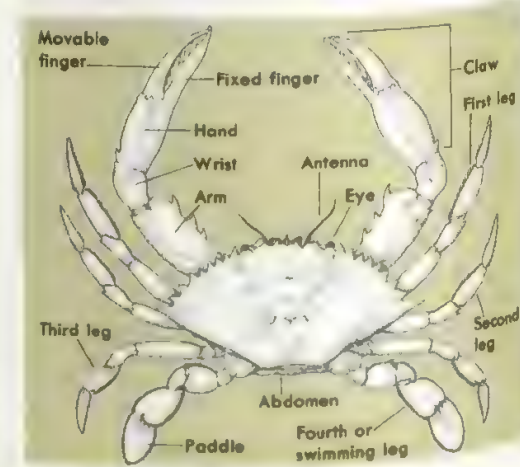
Several crabs live in unusual places. The female pea crab, *left*, lives in the shell of a live oyster. The pine crab, *right*, makes its home in bromeliad plants that grow on tropical trees. It lives in water that collects at the bottom of the plant.

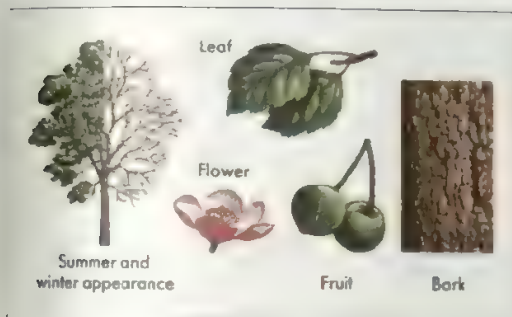
sapidus; the blue swimming crab is *Portunus pelagicus*; the Japanese spider crab is *Chionoectes japonicus*; the mud or mangrove crab is *Scylla serrata*.

Related articles in <i>World Book</i> include:			
Animal (picture:	Blue crab	Hermit crab	
Coconut crab)	Crustacean	Spider crab	
Arthropod	Fiddler crab		

Crab apple is any of a wide variety of small trees that bear apples less than 5 centimetres in diameter. About 25 species of crab apple trees grow wild in the Northern Hemisphere. Most of them originated in Asia. In addition,

Parts of a blue crab





The crab apple tree has large white to deep pink flowers. Its fruit can be eaten fresh or used to make a delicious jelly.

tion, hundreds of *cultivars* (cultivated varieties) of crab apple trees have been produced. Most of these cultivars are grown for use as landscape trees, especially in urban areas. Some are grown for their edible fruits, which are mostly used for making jellies.

Most crab apple trees measure less than 9 metres high. The trees produce white, pink, or red flowers in the spring. Some bear red or yellow fruits that remain colourful through autumn and early winter. Some crab apple cultivars are particularly resistant to diseases and insects. Such cultivars have made the crab apple a popular flowering landscape tree.

Scientific classification. Crab apple trees belong to the rose family, Rosaceae. They are genus *Malus*.

Crab plover is a wading bird found on the shores of the Indian Ocean, from East Africa to Burma, and on the Andaman Islands and Madagascar in the Indian Ocean. The body of the bird is mainly white, with a black back and wings. The bird also has a stout, black bill. The crab plover has long legs, and its toes are partially webbed. It feeds on crabs and other kinds of shellfish, and nests in burrows.

Scientific classification. The crab plover is *Dromas ardeola*, the only member of the family Dromadidae, in the order Charadriiformes.

Crabbe, George (1754-1832), a British poet, brought a direct and often unromantic approach to his work. He portrayed the sordid and unpleasant aspects of life as well as the romantic side. His first published work was *The Library* (1781). *The Village* was published in 1783. In 1807, he published *The Parish Register*, and followed it with *The Borough* (1810), *Tales in Verse* (1812), and *Tales of the Hall* (1819). Benjamin Britten based his opera *Peter Grimes* on *The Borough*. Crabbe was born at Aldeburgh, in Suffolk, England. He became a surgeon, and later a clergyman.

Cradles of civilization. See Asia (History).

Craft. See Handicraft.

Craig, Edward Gordon (1872-1966), a British stage designer, producer, and author, strongly influenced theatre production and the art of stage settings after 1910. He founded a theatre arts journal, *The Mask* (1908), and the School for the Art of the Theatre (1913) in Florence, Italy. His best-known book is *On the Art of the Theatre* (1911). Craig also wrote *The Art of the Theatre* (1905), *Towards A New Theatre* (1913), *Scene* (1923), and *Ellen Terry and Her Secret Self* (1931). Craig was the son

of the famous actress Ellen Terry. He was born at St evenage, in Hertfordshire, England

Craigavon (pop. 74,350) is a local government district located to the south of Lough Neagh, in Northern Ireland. Large towns in the district include Lurgan and Portadown, which are part of the new town of Craigavon. The manufacture of fine linen products is important in the district. Portadown is the centre of a fruit growing and a rose-growing industry. See also Ulster. **Craigavon, Lord** (1871-1940), James Craig, was the first prime minister of Northern Ireland. He held the office from 1921 until his death in 1940. He favoured maintaining the union between Ireland and the United Kingdom. He was elected a Unionist member of Parliament in 1906. He supported Sir Edward Carson in his resistance to the Home Rule Bill (see Carson, Lord). In the coalition government of 1916, he was treasurer of the Household, and, in 1919, became parliamentary secretary to the minister of pensions. In 1920, he became parliamentary and financial secretary to the Admiralty. He was born at Craigavon in Ulster, Northern Ireland, and educated at Edinburgh University, Scotland. He became Viscount Craigavon in 1927.

Crake is a type of bird which lives on the ground, often in swamps or marshes. It is small to medium-sized with short, rounded wings, medium to long legs, and slender toes. Crakes are secretive birds that tend to creep through vegetation and rarely fly. When they do fly, for example, when flushed from cover, they flutter short distances on weak wings with feet dangling. The plumage of the crake is usually brown, faintly streaked or mottled. The bill is short and conical. Similar birds to crakes, but with longer and downwardly curved bills, are generally called rails. In North America, some small species of crake are also called rails.

Crakes are found worldwide. The *corncrake* of the European grasslands is about 25 centimetres long with a stubby yellowish bill. It has a far-reaching, grating call. It nests on the ground. The corncrake winters in Africa. The *red-necked crake* of Queensland is one of several Australasian species. North American crakes include the *sora*, the *yellow rail*, and the *black rail*, the latter, just 15 centimetres long, being the smallest of the three.



The corncrake nests in rough grasslands. It has become rare because of the spread of mechanical haycutting.

Scientific classification. Crakes are in the coot and rail family, Rallidae. The corncrake is *Oxyechus oxyechus*. The red-necked crane is *Rallus tricolor*. The sora is *Porzana carolina*.

Cramp is a painful, uncontrolled contraction of one or more muscles. Cramps may involve any muscular area of the body. There may be only a single *spasm* (contraction) of the muscle, but usually it is followed by more intense cramping that begins and ends quickly and abruptly. A severe muscle spasm may continue for several hours or even days if untreated.

Cramps can occur either in skeletal muscles or in smooth muscles. When work is unusually hard and repetitious over long periods, the involved skeletal muscles often will cramp. Also, cramping is more likely to develop when one works or performs physical activity in the heat. This condition is called *heat cramp* and is associated with heavy sweating and loss of salt from the body. For example, foundry workers and fire fighters do heavy work in the heat and may develop cramps in their arms and legs. Athletes often develop cramps in the muscles they use most strenuously. For example, runners may develop cramps in their legs. Cramps also can develop when certain muscles are used too much in performing ordinary, daily tasks. For instance, a person who writes for a long time may develop writer's cramp.

Perhaps the best-known cramps are those of the smooth muscles of the stomach and intestines. These may result from poor eating habits, or from chilling the stomach. They often cause stomachaches. Cramps are also characteristic of many diseases.

Doctors treat cramps with heat and massage, and give medicines to relieve pain.

Cranach, Lucas, the Elder (1472-1553), was one of the leading German painters of the Renaissance. In his duties as court painter at Wittenberg, Cranach painted many of the great people of his time. He painted portraits of the Protestant leader Martin Luther and Luther's family, but also undertook many commissions for religious paintings for Roman Catholic patrons. In addition, Cranach became known for his humorous versions of Greek mythology.

Like other German artists of his time, Cranach was active in printmaking. He invented the *chiaroscuro* woodcut, which uses two woodblocks to create a picture, one for lines and one for areas of colour.

Cranach was born in Kronach, Bavaria. He took his name from the town and his real name is unknown. His three sons were minor artists.

See also **Luther, Martin** (picture).

Cranberry is a red, sour, round or oval berry that grows on an evergreen vine. Cranberries are used in making cranberry sauce, a traditional Thanksgiving food in the United States. The sauce is also eaten with turkey at Christmas. Cranberries are rich in vitamin C. During the 1800's, many sailors on long voyages ate cranberries to prevent *scurvy*, a disease caused by a lack of vitamin C.

Cranberries grow as evergreen trailing shrubs. They have tiny oval leaves born on wiry stems.

There are a few species of cranberries, all found in the Northern Hemisphere. The small-fruited cranberry is a northern species that grows among moss in boggy places. The flowers are bright pink and the fruits are crimson, often spotted. The larger-berried American



Cranberries grow in cool regions of the Northern Hemisphere. The berries have a sour taste and are rich in vitamin C. The American cranberry, *above*, has the largest berries.

cranberry grows wild in the northeastern United States. It is cultivated on sandy soils enriched with organic matter. The southern cranberry, or red huckleberry is found in mountain areas of the Southern United States.

Scientific classification. Cranberries belong to the heather family, Ericaceae. The northern cranberry is *Vaccinium oxycoccus*; the American cranberry is *V. macrocarpon*; the southern cranberry is *V. erythrocarpum*.

Crane is the name of a family of large birds with long legs and a long neck. Cranes live in marshy areas in many parts of the world. South America and Antarctica are the only continents that have no cranes. Cranes resemble herons, but they can easily be distinguished in flight. Cranes extend their head and neck straight ahead when they fly, but herons bend theirs into an S-shape.

Appearance. Cranes have long and slender legs, necks, and bills. The tallest cranes stand about 1.5 metres high, and the shortest are about 1 metre tall. A crane's wingspan can measure up to 2.5 metres. The male and female look alike. They range in colour from white to dark grey and brown. Most adult cranes have a patch of red skin on the head.

Habits. Most cranes that live in the Northern Hemisphere migrate south each autumn from nesting grounds in the north. They return to their nesting ground each spring. Other cranes remain throughout the year in warm areas. A crane's powerful, buglelike voice carries for a great distance. The birds call to each other in flight, perhaps to keep the flock together during migration.

Cranes mate after they reach their nesting grounds. The male and female perform a dance before mating. The birds alternately circle around each other with opened wings, bow their heads, and leap into the air.

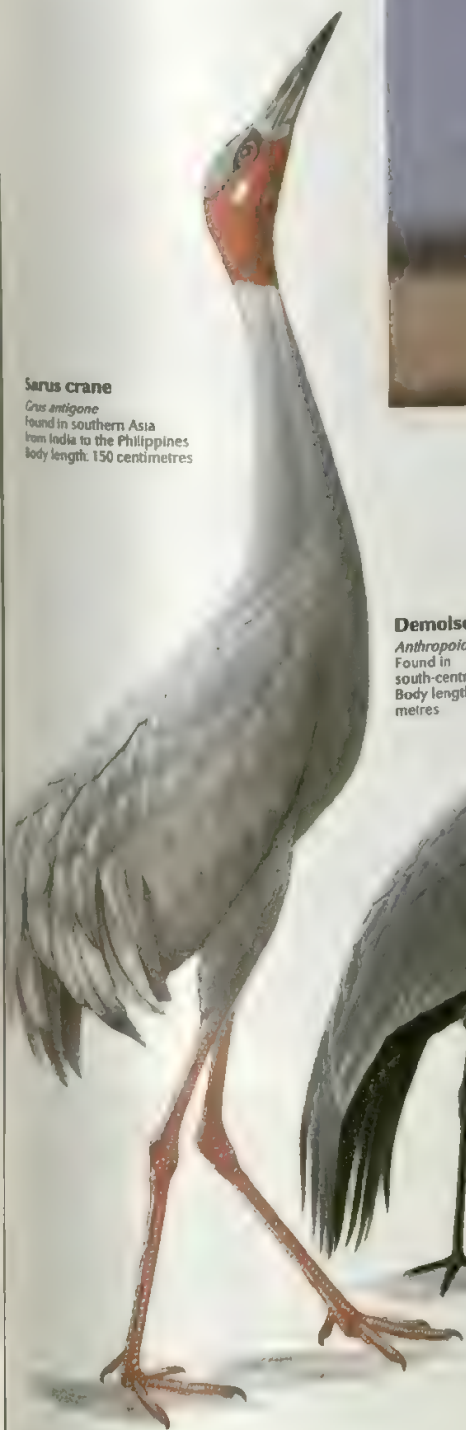
Cranes build nests in shallow water in a marsh, swamp, or other wet, open area. Both the male and the female help pile grasses, weeds, and other plants into a

The whooping crane, right, is the tallest bird of North America. The bird has a wingspread of 1.8 to 2.4 metres. It stands 1.2 to 1.5 metres tall. The whooping crane nests in northern Canada and spends the winter in Texas.



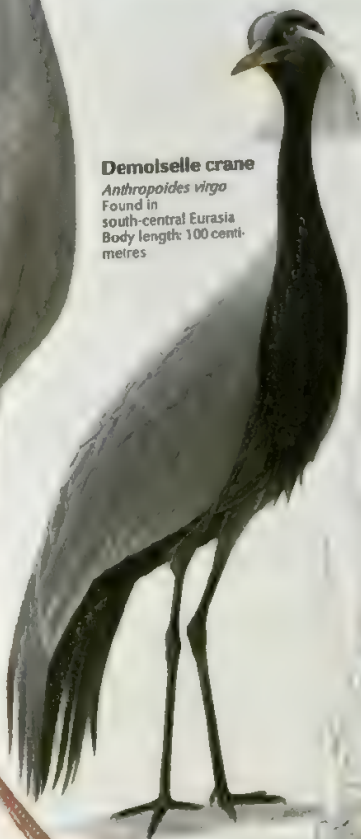
Sarus crane

Grus antigone
Found in southern Asia
from India to the Philippines
Body length: 150 centimetres



Demolselle crane

Anthropoides virgo
Found in
south-central Eurasia
Body length: 100 centimetres



Sandhill crane

Grus canadensis
Found in northern and
southeastern North America
and northern Russia
Body length: 110 centimetres



mound. A female crane usually lays only two eggs in a season. Both parents care for the eggs and young.

Cranes eat a variety of foods, including frogs, insects, snails, and grain and other plants. They are a pest in some areas because they take grain from farmers' fields.

Kinds. There are 15 species of cranes. Most live in Africa, Asia, and Europe, and only two species are native to North America.

The *common crane* breeds in northern Europe and much of Asia. It has a grey body and a white stripe from eye to neck. The *Sarus crane* of southern Asia is blue-grey and is one of the tallest cranes. It is prized by the Hindus, who believe that the sight of a pair of these birds brings good luck. The *Australian crane*, or *broilga*, has a green crown and a red face and head. See *Broilga*. The *African crowned crane* has dark body feathers and a tuft of light-coloured feathers on its head. The dancing of this bird is believed to have been a model for the dances of people in West Africa.

Whooping cranes, or *whoopers*, once nested on the prairies of the United States and Canada. They began to die out during the 1800s, when settlers disturbed their nesting grounds. By 1954, only one flock of 21 birds remained. Laws now protect whoopers and their habitat. Scientists are breeding whoopers in captivity, and they have started a second flock in the wild. Today, about 157 whooping cranes survive in the wild, and some 55 birds are in captivity. But they remain one of the rarest birds in North America. See *Whooping crane*.

Sandhill cranes nest in northern Russia, Canada, and the northern United States, as well as in Florida, Georgia, Mississippi, and Cuba. Migrating sandhill cranes travel in enormous flocks, which may include more than 100,000 birds. Several species of cranes have become rare as marshes in many areas have been drained for farming and for settlements.

Scientific classification. Cranes make up the crane family, Gruidae. The common crane is *Grus grus*; the Sarus crane, *G. antigone*; the Australian crane, *G. rubicunda*; the crowned crane, *Balearica pavonina*; the whooping crane, *Grus americana*; and the sandhill crane, *G. canadensis*.

See also *Bird* (Bird refuges; Endangered species).

Crane is a hoisting machine used to lift and move heavy loads in shipyards and factories, and at construction sites. Most *cranes* can move under their own power. A stationary hoisting machine is often called a *derrick*. Engineers use either name for the machine.

Cranes. The *hand-operated jib crane* is the simplest type of crane. It has a long *jib*, or arm, that extends several feet from a heavy base. The base keeps the crane from tipping over. The end of the jib has a pulley. A rope or a cable, with a lifting hook in the end, runs from this pulley to a *winch* (crank) in the foundation. The operator turns the winch to lift or lower the hook. The arm of the crane can be swung in a circle before the weight is lowered. Thus, a jib crane can move a weight to any point around the circumference of the circle its jib makes. The *pillar jib crane* has a pillar rising from its base. A cable attached to the top of the pillar raises and lowers the end of the jib so that the jib can be moved up and down as well as from side to side. When the jib moves up, it carries the load toward the base of the crane. When lowered, it moves the load away from the base.

Factories and foundries often use *bridge cranes*, sometimes called *overhead travelling cranes*. This type of crane moves back and forth on a bridge extending across the width of a factory building. The bridge travels the length of the roof on overhead rails. *Locomotive cranes* are mounted on railway wagons and have long power-operated booms. *Crawler cranes* are mounted on tractors. *Truck cranes*, frequently used by building contractors, are mounted on trucks. *Tower cranes* are used to construct high-rise buildings. Most tower cranes, called *climbing cranes*, have built-in jacks that raise the cranes through openings in the floor as the building goes up.

Derricks. The *gin-pole* is the simplest derrick. It has a *mast*, or pole, supported by four *guys*, or cables, staked to the ground. A pulley at the top of the mast supports ropes to lift the weight. The *sheers derrick* has two crossed masts and two guys. Other derricks have a long *boom*, or pole. It slants out from the mast's base and supports the hoisting cable that carries the load. A cable attached to the top of the mast supports the boom. *Oil derricks* are tall steel structures that raise and lower the equipment used to drill oil wells.

See also *Block and tackle*; *Construction equipment* (pictures); *Petroleum* (pictures).

Crane, Hart (1899-1932), was an American poet best known for his complex work *The Bridge* (1930). Crane used the Brooklyn Bridge in New York City as his major symbol of the meaning and texture of modern life in the United States. Crane incorporated history, geography, and technology into an abstract, mythological vision of America's past, present, and future.

In *The Bridge*, Crane interwove legendary figures from American history with modern inventions. For example, he portrayed Rip Van Winkle as a passenger on a New York City subway. The subway itself is a vehicle that carries the reader backward into America's past and forward into a vision of the future. Although Crane was optimistic about life in the United States, his poem shows his awareness of the problems created by an industrial society. Crane published one other book of poems during his lifetime, *White Buildings* (1926).

Harold Hart Crane was born in Garrettsville, Ohio, U.S.A. He had an unhappy personal life and committed suicide at the age of 32.

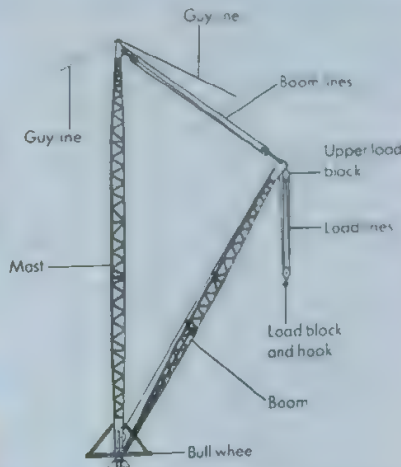
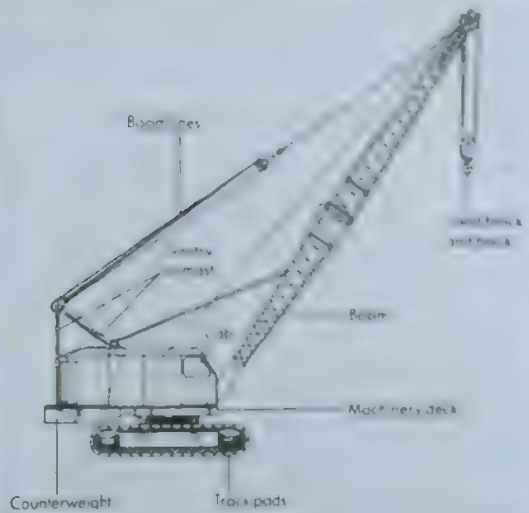
Crane, Stephen (1871-1900), was an American novelist, short-story writer, and poet. He produced an impressive number of realistic works, though he died of tuberculosis when he was only 28 years old.

Crane was born in Newark, New Jersey. In 1891, he moved to New York City. There, his observations of slum life as a free-lance journalist inspired his first novel, *Maggie: A Girl of the Streets* (1893). Crane showed himself a master of irony in his sympathetic portrait of Maggie, who was driven to prostitution in her teens.

Crane's next and greatest novel, *The Red Badge of*



Stephen Crane



Cranes are designed for specific purposes. The truck crane, upper left, is mounted on a truck. It is widely used in construction. The crawler crane, above, is mounted on a tractor. It can be used to carry loads from place to place. Derricks, left and far left, are stationary cranes used to lift heavy loads. A guy derrick, left, has a long boom that can move loads from side to side.

Courage (1895), takes place during the American Civil War. It tells the story of Henry Fleming, a young Union soldier whose romantic illusions of war are brutally shattered by the reality of war's confusion and bloodshed. *The Red Badge of Courage* earned Crane an international reputation.

Crane's fame as an author of realistic war fiction brought him assignments in the late 1890's as a correspondent in the Greek-Turkish War and the Spanish-American War. During these years, he published his most famous short stories-- "The Open Boat" (1897), based on his experiences following a shipwreck, and "The Blue Hotel" (1899). Crane spent his last two years in failing health, writing in Europe.

Crane, Walter (1845-1915), was a British artist who became famous for his illustrations for children's books. Crane's illustrations are noted for their flat colours and attention to detail. His bold, simple compositions reflect his interest in Japanese prints.

Crane was best known for his pictures for more than 30 *toy books*, which were small volumes of nursery rhymes and fairy tales for young children. His toy books include *Sing a Song of Sixpence* (1866), *Beauty and the Beast* (1874), *Little Red Riding Hood* (1875), and *Aladdin* (1875). Crane created some of his best illustrations for two books of nursery rhymes set to music by his older sister, Lucy. The books were called *The Baby's Opera* (1877) and *The Baby's Bouquet* (1878).

Crane also created illustrations for adult books, as well as oil paintings, murals, and posters. In addition, he designed tapestries and wallpaper. He was born in Liverpool, England.

See also **Literature for children** (The rise of illustration).

Crane fly. See **Daddy longlegs**.

Cranium. See **Head**.

Cranmer, Thomas (1489-1556), was the first Protestant archbishop of Canterbury, the leader of the Church of England. He became a leading figure of the English Reformation, which was the religious movement that led to the establishment of Protestantism in England.

Cranmer was born at Aslockton, in Nottinghamshire. He attended Cambridge University, became a fellow of Jesus College, and was ordained to the priesthood by 1520. Cranmer came to the attention of King Henry VIII in 1529, when he met with the king's advisers concerning Henry's divorce proceedings against Catherine of Aragon. Henry's wish to divorce Catherine conflicted with doctrines of the Roman Catholic Church. Cranmer suggested that the divorce question be put to theologians at the universities for judgment rather than to the pope. In 1532, Cranmer was sent as part of a delegation to Europe, which met with political leaders and theologians.

In Germany, Cranmer also married the niece of a religious reformer. Cranmer kept the marriage secret because it violated his priestly vows. In 1533, Cranmer became archbishop of Canterbury. He supported Henry's efforts to divorce Catherine and to separate the Church of England from the Catholic Church. See **Henry [VIII] of England**.

During Henry's reign, Cranmer authorized using an English language Bible in parish churches and published an English version of a form of prayer called a *litany*. During the reign of Edward VI, Cranmer organized the preparation of the *Book of Common Prayer* (1549). He also shaped a statement of doctrine that eventually became the Thirty-Nine Articles of the Church of England.

In 1553, Mary, the daughter of Henry VIII and Catherine of Aragon, came to the English throne. Mary, a devout Roman Catholic, had Cranmer imprisoned. In 1554, he was charged with heresy. Two years later, he was burned at the stake.

Crashaw, Richard (1613-1649), an English poet, wrote poetry that is noted for its sensuous mysticism and for its extravagant imagery. Most of his best-known poems were collected in *Steps to the Temple* (1646). Crashaw was born in London. He graduated from Pembroke College, Cambridge University, and became a fellow of Peterhouse College. He lost his fellowship because of his sympathies towards Roman Catholicism. In 1645, he went to Paris. He became a Catholic, and later travelled to Rome.

Crassus, Marcus Licinius (112?-53 B.C.), was a Roman statesman, financier, and military leader. Crassus, Caesar, and Pompey formed the *First Triumvirate* (a three-man ruling body) in 60 B.C. Crassus had previously held the high government posts of praetor, consul, and censor. He was called *the Rich* because he made much money through property investments. He used his position to gain favours for his friends in business.

In 71 B.C., Crassus crushed the revolt of the gladiator Spartacus (see **Spartacus**). Seeking military glory, Crassus launched a war against Parthia, an area in central Asia. In 53 B.C., Parthian archers trapped his army, and killed Crassus and most of his troops.

See also **Caesar, Julius**; **Triumvirate**.

Crater is a funnel- or bowl-shaped depression on the surfaces of planets and other bodies in the solar system. Most craters on the earth are formed by volcanic activity. Some of these craters result from explosions that blast cinders and other debris from volcanic vents. Such craters are rarely larger than 2 kilometres across. Other craters form when the ground surface collapses following the withdrawal of lava from below. The depression occupied by Crater Lake in Oregon, United States, and the crater of Kilauea in Hawaii were both formed by collapse. Collapse craters larger than 1 kilometre across are called *calderas*. Smaller collapse craters are called *pit craters*. Craters are common on the moon and on planets other than the earth. But almost all the craters on these bodies are *impact craters* that were formed by the impact of large meteorites. See also **Meteor** (Meteorites; picture); **Moon**.

Craven (pop. 49,700) is a local government district in North Yorkshire, England. The district comprises the market town of Skipton and the surrounding rural area. Much of the beautiful Yorkshire Dales National Park is in Craven. The three peaks of Wharfedale, Ingleborough, and Pen-y-ghent are in Craven. See also **Yorkshire**.

Craven, Danie (1910-1993), became South Africa's leading Rugby Union football administrator. He dominated South African rugby after becoming president of the South African Rugby Board in 1956.

Craven was born in Lindley, Orange Free State. During the 1930s, he played scrum half for South Africa. In 1938, he captained the national team in matches against a British touring team. Craven served as a national selector from 1949 to 1956. He was manager of the National Springbok Rugby Team in 1956. As president of the Rugby Board, Craven tried to have South African teams accepted back into international competition. In 1988, he caused a sensation in South Africa by entering into discussions with the African National Congress, which at that time was banned.

Crawfish. See **Crayfish**.

Crawley (pop. 87,100) is a new town and local government district in West Sussex, England. Crawley's industries include engineering, electronics, pharmaceuticals, and cleaning products. The district also includes one of the United Kingdom's major airports, Gatwick. See also **Sussex**; **New town**.

Crayfish, also called *crawfish*, is a freshwater crustacean that is closely related to the lobster. It lives in and along lakes and rivers and is found on every continent except Africa and Antarctica. Australia has the largest number of freshwater crayfish, including many colourful species. The largest species of crayfish, which grows up to 40 centimetres long and weighs up to 6 kilograms, lives in Australian waters. Most crayfish are sandy brown or greenish and average 10 centimetres in length.

A hard structure called the *exoskeleton* covers the body of the crayfish. This serves as a suit of armour to protect the soft tissues of the body from injury. The

body is divided into sections, or segments. The front part of the body is rigid, but the back part, or abdomen, has movable segments. The crayfish has five legs on each side of the body. The two front legs are shaped into large, sharp claws, or pincers. They are similar to those of the lobster and are used to capture and hold the prey. The four other pairs of legs are used for walking. *Swimmerets* (leglike structures used in reproduction) are located under the abdomen. The crayfish has two long and two shorter feelers, or antennae.



Crayfish

The crayfish feeds on snails, small fish, tadpoles, or the young of insects. It is more active at nightfall and at daybreak, when it comes out of its burrow or from under a stone. If a crayfish loses a limb it can grow a new one.

Crayfish are considered good to eat in many countries. In the United States, large numbers of crayfish are reared in fish farms. In Sweden, people hold crayfish parties outdoors in the summer. They eat crayfish dressed with the herb dill.

Scientific classification. The giant Australian crayfish is *Asiatopsis gouldi*; the European crayfish is *Astacus fluviatilis*; North American crayfish include *Cambarus virilis* and *C. bartoni*.

See also Crustacean; Lobster.

Crayon is a piece of coloured wax shaped like a pencil. Coloured pencils, coloured chalk, and *pastels* (sticks made of a chalky paste) are sometimes called crayons. This article discusses wax crayons.

Children use crayons to colour pictures and to create bright, colourful drawings. Crayons can be used for marking such surfaces as paper, wood, and cloth.

To make crayons, manufacturers add natural or synthetic *pigments* (colouring materials) to heated wax. The mixture is then poured into moulds. After the crayons harden, they are wrapped in paper.

See also Pastel; Pencil (Coloured pencils).

Crazy Horse (1844?-1877) was a chief of the Oglala Sioux Indians. In 1875, the U.S. government ordered Crazy Horse and other Sioux Indians to enter a reservation. But they refused. In 1876, the U.S. Cavalry attacked a Cheyenne village, believing it was Crazy Horse's village. Seeking revenge, Crazy Horse became a leader in the Sioux War of 1876. He led the Sioux and Cheyenne, who defeated General George Crook in the Battle of the Rosebud in Montana. Eight days later, he led the Indians in the Battle of the Little Bighorn, where Lieutenant Colonel George A. Custer and his command were wiped out (see Custer, George Armstrong).

In 1877, Crazy Horse voluntarily surrendered to American troops. He was killed in 1877 at Fort Robinson, Nebraska, by a soldier while the chief was being forced into a jail cell.

Cream. See Milk (table); Butter.

Cream of tartar, also called *potassium bitartrate*, or *potassium hydrogen tartrate*, is a white, crystalline substance with a slightly acid taste. It is found in grapes and other fruits. It is used in baking recipes, and in the manufacture of baking powder. It is also used in tin-plating metals and as a laxative in medicine. Cream of tartar comes from *argol*, the crude tartar sediment that settles in wine barrels. Cream of tartar has the chemical formula $\text{KHC}_2\text{H}_3\text{O}_6$.

See also Baking powder.

Creasey, John (1908-1973), a British author, became one of the best-known writers of detective stories of the 1900's. He published more detective fiction than any other writer of his time—almost 600 novels written under 28 names. Most critics consider Creasey's stories uneven in quality but have praised his best ones for their fast-paced action and clever plots.

Creasey created several detectives. Under his own name, he wrote three separate series of novels about Inspector Roger West of Scotland Yard and two amateur detectives, Dr. Stanislaus Palfrey and Richard Rollison. Rollison is known as the Toff, an English slang word for a stylishly dressed man. Perhaps Creasey's most popular detective is Commander George Gideon of Scotland Yard. Under the name of J. J. Marric, Creasey wrote the Gideon series, the best example of the British police procedural novel. Creasey's other pen names include Gordon Ashe, Norman Deane, Michael Halliday, Kyle Hunt, and Jeremy York. Creasey was born in Surrey, England.

Creation. See Life (The origin of life).

Creationism, Scientific. See Scientific creationism.

Crécy, Battle of, was the first important battle of the Hundred Years' War. It took place in 1346 at the site of the present town of Crécy, in the French department of Somme. English troops under Edward III defeated a much larger French army under Philip VI. Almost half the French force was killed, including more than a thousand knights. English archers on foot proved more effective than armour-clad French knights on horses. The Battle of Crécy was one of the first times English soldiers used gunpowder. The hero of the battle was Edward, the Black Prince, son of Edward III of England. See also Edward; Edward (The Black Prince); Hundred Years' War.

Credit enables people to obtain goods or services even if they do not have enough money to pay for them right away. For example, a person who cannot immediately pay the full price of a car or a house may make the purchase on credit.

The word *credit* comes from the Latin word *credo*, meaning *I trust*. Moneylenders trust borrowers to pay them back. Sellers give credit to buyers because it increases sales and, ordinarily, the buyers pay interest. Buyers willingly pay interest for credit because they can use things they want while paying for them.

A *credit rating* establishes the extent to which a person or company can buy on credit or borrow money. Factors that contribute to a credit rating include income, financial reliability, and records of previous credit transactions. Organizations called *credit bureaus* compile credit ratings and provide this information to shops, business firms, and lending institutions.

Credit can promote economic growth and contribute to a nation's wealth. Business companies use credit to build factories or to buy equipment in order to increase the production of goods. Governments use credit to build schools, roads, and other public projects.

Types of credit. There are three major types of credit—*consumer*, *commercial*, and *investment*.

Consumer credit enables consumers to spend more money than they have at the time. A charge account or credit account is one kind of consumer credit. Most charge accounts involve no interest, but the full price of items bought through a charge account must be paid monthly. If the full amount is not paid by the specified date, many charge accounts require interest payments. Banks issue credit cards that can be used to charge purchases at many shops, restaurants, and other businesses. Another kind of consumer credit is a hire purchase agreement. Payments on a hire purchase agreement are made over a stipulated period of time and, in most cases, include interest.

Commercial credit is used by companies to develop their business. They expect to repay the loans from their increased profit. Most of these loans are repaid within six months and so are called *short-term credit*.

Investment credit is a loan paid back over a period as long as 30 years, or even more. This kind of loan is called *long-term credit*. Examples include home mortgages and corporate bonds. Businesses use investment credit to undertake a major project, such as the construction of a factory.

Lending institutions take money received from savers and other customers and lend it on credit to those who need funds. Such institutions include banks, building societies, credit unions, finance companies, and insurance firms.

The terms of a loan are set forth in a loan contract. These terms include *interest*, *maturity*, and *security*. Interest is paid by the borrower to the lender. It serves as compensation for giving up the use of the money, for waiting for repayment of the loan, and for risking the loss of the money. Maturity is the date by which the loan must be completely repaid. Security is something of value that a borrower pledges to the lender in case the loan is not repaid as promised. For example, the title of a house is the security on a home mortgage.

Credit and the economy. The availability of credit affects both the rate of economic growth and the level of prices. When credit is easy to get, people are able to buy more, and their demand for goods and services grows. In response to the growing demand, business companies may try to hire more workers to increase output. Credit also enables firms to buy new equipment to boost production. However, if output does not keep pace with demand, prices will increase. A continuing increase in prices is called *inflation*.

During periods of inflation, moneylenders may hesitate to grant credit. Inflation drives down the purchasing power of money, and so the money that lenders get back buys fewer goods and services than the amount they lent. If lenders expect a period of inflation to continue, they may raise interest rates to make up for the loss in money value. When credit becomes harder to obtain, the reverse situation may result. Economic activity may decline, and inflation may slow down or stop.

Related articles in *World Book* include:

Bank	Credit card	Inflation
Building society	Credit union	Interest
Collection agency	Finance company	Mortgage
	Hire purchase	Pawnbroker

Credit, Letter of. See *Letter of credit*.

Credit card is a plastic card which allows the holder to buy goods, services, and (sometimes) foreign currency on credit. Bank credit cards are widely accepted by many shops, hotels, restaurants, and businesses worldwide. Cardholders are usually invoiced monthly and, if they wish to delay payment, they pay a high rate of interest on the unpaid balance.

Some retail stores, hotel chains, and other businesses issue cards for use only in their own outlets. The first cards were issued by major U.S. companies in the 1920s to facilitate payment at, for example, their hotels. Since 1950, when Diners Club Inc. introduced the first card for use at more than one outlet, the use of credit cards has become extremely popular and widespread. Among the most accepted cards internationally are Visa and Mastercard/Eurocard/Access. These organizations have issued hundreds of millions of credit cards in many countries.

Credit cards carry the cardholder's name and account number. The cardholder benefits from the easy payment service it provides; organizations that accept cards benefit from increased business; and the issuers profit from the high interest charged on unpaid balances, their fees and their commissions. Credit cards are sometimes criticized because they encourage people to spend more than they can afford.

Credit union is a cooperative banking association operated exclusively for the benefit of its members. The members pool their savings and borrow money at a rate of interest sometimes lower than the interest charged by most banks. Savers are paid a dividend. Credit unions are often organized among the employees of companies or members of farm groups, trade unions, and educational, religious, and social institutions. They are extremely popular in the United States. In the early 1980s, there were about 20,000 credit unions in the United States with a membership of about 45 million.

Cooperative credit societies originated in Germany during the 1840s. Alphonse Desjardins organized the first credit union in North America in 1900 in Lévis, Quebec. Desjardins helped set up the first credit union in the United States in Manchester, New Hampshire, in 1908. In 1909, Massachusetts became the first state to legalize credit unions. In Britain, the first credit union was started by West Indian and Irish immigrants in the early 1960s. They appeal in particular to the lower income groups, who may not have bank accounts. The Credit Union Act of 1979 sets out the conditions under which credit unions may be formed and operated.

Creed, Apostles'. See Apostles' Creed.

Creed, Nicene. See *Nicene Councils*.

Creeper, also called *treecreeper* is the name of many species of small, woodland birds that live in most parts of the world. The *common creeper* is found throughout Europe, northern Asia, and North America. Creepers measure about 13 centimetres long and have a long, thin bill. The upper parts of the body are mainly brown and the underparts are white.

Creepers eat small insects and spiders found on and in the crevices of tree bark. These birds search for food almost continually. They "creep" up tree trunks in quick, jerky movements, using their long, stiff tail as a prop. After reaching the top of the tree, they fly down to a different tree and begin their upward hunting movements again.

Creepers make their nests behind loose flaps of bark. They build the nests of twigs, strips of bark, and feathers. The female lays 5 to 8 eggs, which are white but speckled with reddish-brown. In the autumn, creepers that live in regions with cold climates may migrate to warmer areas. Those that stay in cold regions often huddle together in groups of from 2 to 15 birds to stay warm.

Scientific classification. Creepers belong to the tree-creeper family, Certhiidae. The common creeper is *Certhia familiaris*.

Creeping bent. See Bent.

Creeping thistle is one of the most troublesome of weeds. It is native to Europe and Asia and now grows throughout most of the northern United States and southern Canada. The thistle has prickly leaves and small pink, purple, or white flowers.

The creeping thistle annoys farmers because it grows in cultivated areas as well as in wasteland, and it is difficult to control. The thistle spreads easily because new plants can grow from bits of the roots of old plants. If a plant is only partly uprooted, several plants can still grow from its remaining roots.

The plant can be destroyed in several ways. One way is to kill its roots through starvation. The leaves supply the food that keeps the roots alive. This food supply can be cut off by cutting down the green stems of the plant as soon as they appear. This method can be combined with the growing of crops, such as maize, that require cultivation between rows. Cultivation brings the thistle seeds nearer the surface so they may start growing. Later, the stems are cut down. Chemical weed killers are also used to destroy the plant.

Scientific classification. The creeping thistle belongs to the daisy family, Compositae (Asteraceae). It is classified as *Cirsium arvense*.

Cremation is burning a dead body to ashes. Burial is the most common method of disposing of the dead in most countries, but the practice of cremation is increas-



The creeper uses its stiff tail feathers and sharp, curved claws to climb a tree.

ing. Some people who request cremation consider burial in a cemetery undignified. Others feel it is a wasteful use of land.

Most funeral directors can arrange a cremation. A funeral service may take place before or after the burning. The cremation is performed in a building called a *crematory* or *crematorium*. The body is put in a coffin or other container, which is burned in a special oven from one to four hours. The remaining bones are then crushed into white, powdery ashes. The ashes are placed in a container called an *urn* and given to the relatives of the dead person. The relatives may keep the ashes, bury them in a cemetery, or place them in a special burial vault called a *columbarium*. Some people request that their ashes be scattered in one particular place, such as a favourite lake.

Cremation has been practised throughout history. It was not used by the ancient Chinese or Egyptians. But the ancient Greeks and Romans practised it. They believed that burning the body purified the soul and released it from its earthly form. The early Christians believed in the eventual reuniting of the body and soul, and viewed cremation as a form of disrespect.

Cremation remained uncommon in Christian countries until the 1800s. Then concern about land use in urban areas and increasing opposition to church restrictions helped reawaken interest in cremation. The first legally recognized crematory for public use opened in Milan, Italy, in 1876. Today, cremations account for the disposal of about 50 per cent of the dead in Australia, about 70 per cent in the United Kingdom, and about 15 per cent in the United States. Cremation is most common in Japan, where over 95 per cent of the dead are cremated.

Cremer, Sir William Randal (1838-1908), a British politician, advocated a system of international arbitration that would enable countries to settle their differences peacefully. He won the Nobel Peace Prize in 1903. During the Franco-Prussian War (1870-1871), Cremer founded the Workmen's Peace Association, later renamed the International Arbitration League, with the aim of keeping Britain neutral during the war. He worked for an arbitration agreement between Britain and the United States. Cremer was born at Fareham, in Hampshire, England.

Creole, in North or South America, is a person whose ancestors were early French or Spanish settlers of the New World. The word *Creole* comes from the Spanish word *criollo*, meaning *native to the place*. The term also refers to Creole foods and other aspects of Creole culture. In the United States, a Creole is a descendant of French and Spanish settlers of the Gulf States, such as Louisiana. Many Creoles speak a form of French, Spanish, or Portuguese. Creole foods include *gumbo*, a kind of soup; and *pralines*, a sweet. See also **Cable, George Washington**.

Creosote is a heavy, oily liquid made by distilling wood or coal tar. It has a penetrating, smoky smell and is nearly colourless when pure. Creosote as sold in shops is commonly a brownish colour, and is a mixture of cresol and several other substances. Creosote oil taken from beechwood tar has been used in medicine. This oil is made chiefly of creosote and guaiacol. Creosote obtained by distilling coal tar is one of the most ef-



Creeping thistle

fective wood preservatives. It has been used for this purpose for more than 100 years. However, creosote is poisonous. In addition, tests have shown that the substance causes cancer in laboratory animals and may cause cancer in human beings. In 1986, the United States began restricting the use of creosote as a wood preservative. See also **Cresol**; **Tar**.

Crescent is a symbol that resembles the moon in its first quarter. In heraldry, the crescent is a symbol of the second son in a family.

The people of Byzantium (now Istanbul, Turkey) used the crescent of Diana, a moon goddess in Roman mythology, as their symbol. When the Turks conquered the city, they adopted it as their symbol. It appears on the flag of Turkey. In addition, many countries with large numbers of *Muslims* (followers of Islam) feature a crescent on their national flags.

Cresol is the common name for a group of chemicals that scientists called *hydroxytoluenes*. Creosote oil contains cresols, and is used to preserve railway sleepers, fence posts, and other wood used outdoors. Antiseptic soaps and emulsions are made from a purified mixture consisting of the known cresols: ortho-cresol, meta-cresol, and para-cresol. These soaps and emulsions are used as local antiseptics and disinfectants. See also **Creosote**.

Cress is any one of three green plants in the mustard family. They are used in salads and to garnish meats. The best-known cress plant is called *water cress* because it grows in water in sandy stream bottoms. It has smooth, bright-green leaves on long slender stems. *Garden cress*, or *peppergrass*, has a sharper taste than water cress. It is often grown together with mustard seeds and sold as mustard and cress. *Swedish cress*, sometimes called *upland cress* or *winter cress*, grows in northern Europe.

Water cress may be raised as a winter crop in greenhouses. It grows best in running water. Garden cress is usually planted in the early spring and harvested about six or seven weeks later. The cresses are rich in minerals, but are usually eaten in too small amounts to provide much food value.

Scientific classification. Cresses belong to the mustard family, Cruciferae (Brassicaceae). Water cress is *Nasturtium officinale*. Garden cress is *Lepidium sativum*. Swedish cress is *Barbarea vulgaris*.

See also **Mustard**.

Crested swift, or *tree swift*, is the only swift that has feet adapted for perching. There are three species that range from Southeast Asia to Australia. They have plume-like crests that can be made erect. The nest of the crested swift is a tiny structure, just 2.5 centimetres across; it is paper thin, and is attached to the side of a thin branch. Crested swifts hunt flying insects, usually at dusk, when they dart out from their perch to snap up any that come within range.

Scientific classification. Crested swifts belong to the family Hemiprocidae, genus *Hemiprocne*.

Cretaceous Period is a period in the geologic time scale of the earth's history. Scientists believe that the Cretaceous Period began 138 million years ago.

See also **Earth** (table: Outline of the earth's history).

Crete (pop. 502,165) is a Greek island in the Mediterranean Sea. The first important European civilization, the

Minoan culture, began on Crete about 5,000 years ago. The island is located about 100 kilometres south of the Peloponnesus, the southern peninsula of mainland Greece. For the location of Crete, see **Greece** (map).

Crete covers 8,332 square kilometres and is the largest island of Greece. Khania is the capital of Crete. Iraklion, the island's chief commercial centre and port, is the largest city.

The people of Crete speak Greek, and most of them belong to the Eastern Orthodox Church of Crete. Cretans are proud of their historic past and follow many old customs. For example, they perform traditional dances and folk songs at weddings and baptisms and on saints' days. Early every evening, the people of Crete's towns put on their best clothes and stroll up and down one of the main streets. Cretans have strong family ties, and many parents arrange marriages for their children. The men of Crete spend much of their time in cafes, where they chat and read newspapers.

Land and climate. A chain of mountains extends across the centre of Crete in an east-west direction. The highest point is Mount Ida, which rises 2,456 metres in central Crete. Fertile valleys and plains lie among the mountains, which drop off sharply to the sea along most of the southern coast. The mountains slope more gradually in the north, and a narrow plain extends along the northern coast.

Crete has hot, dry summers and mild, moist winters. Temperatures average 12° C in winter and 24° C in summer. Rain falls chiefly from October to March and is heavier in the mountains than on the plains and valleys. A number of Crete's farming areas require irrigation because they do not get enough rain. Windmills furnish power for the irrigation systems.

Economy. Most Cretans work on small farms and do much of the work by hand. The main crops are fruits, including grapes, olives, and oranges. The farmers also grow vegetables and nuts.

In the northern coastal cities, factories process food and make building materials. Factories in Iraklion make soap and leather goods. Many of the people are craftworkers, working at such handicrafts as basketmaking and metalwork.

Tourism plays an important part in Crete's economy. The ancient Minoan relics at the Iraklion Museum, and the Minoan ruins at Knossos and Phaistos attract large numbers of visitors. Iraklion and other coastal cities have modern hotels and restaurants.

Government. Crete is governed by the central Greek government in Athens. The island is divided into four *nomoi* (departments), each headed by a *nomarch* (governor) appointed by the minister of the interior.

History. The first people to settle in Crete came from Asia Minor (now Turkey) about 6000 B.C. By about 3000 B.C., the Cretans had developed an advanced civilization. It is called the *Minoan* culture, after the legendary King Minos (see **Minos**). During the Minoan period, the Cretans made great advances in art, architecture, and engineering. They built beautiful palaces with spacious courtyards. They excelled at making pottery and jewelry and also used a system of writing. For more information, see the *World Book* article on *Aegean civilization* (The Minoan culture).

Fire destroyed many towns and palaces of Crete after



Windmills provide power for irrigation on farms throughout Crete. Most Cretan farmers must irrigate their land because of the dry climate. Their crops include wheat and potatoes.

about 1450 B.C., and the civilization gradually declined. The Romans invaded the island in 68 B.C. and made it a province in 66 B.C. After the division of the Roman Empire in A.D. 395, Crete came under Greek rule as part of the Byzantine Empire. Venice ruled the island from 1204 to 1669. Then the Ottoman Turks ruled Crete from 1669 to 1898.

A movement for union with Greece developed in Crete during the 1800's, and Crete became part of Greece in 1913. German forces conquered Crete in 1941, during World War II. The Germans controlled the island until several months before the war ended in 1945. After the war, Crete greatly improved its roads and tourist facilities. Today, it ranks as a major attraction for visitors to Greece.

See also **Architecture** (Classical architecture: Minoan); **Clothing** (Ancient times; pictures); **Knossos**; **Painting** (Origins and early painting [Cretan painting]).

Cretinism is a condition in which babies are born with underdeveloped brains and poorly formed skeletons. Individuals afflicted with cretinism are called *cretins*. Cretinism is caused by the failure of the thyroid gland to begin functioning during the early stages of the development of a fetus (unborn child). The thyroid gland produces hormones necessary for growth and maturation of the body and brain. It normally begins functioning during the 12th week of fetal development. The absence of thyroid hormones disrupts normal growth patterns.

Doctors treat cretinism with supplemental thyroid hormones. Treatment must begin in the first six weeks after birth to prevent both physical and mental retardation.

See also **Thyroid gland**; **Paracelsus, Philippus**. **Creutzfeldt-Jakob disease** is a rare form of dementia that destroys the cells of the brain. Two German neuropsychiatrists Hans G. Creutzfeldt and Alfons M. Jakob, first described the disease in the early 1920's. In most cases, the earliest symptom of Creutzfeldt-Jakob disease is loss of memory or peculiar behaviour. Within weeks, visual disturbances, lack of coordination, muscular weakness, and seizures occur. Intellectual ability and

awareness continue to deteriorate, and the illness progresses rapidly to death, usually within a year.

Creutzfeldt-Jakob disease can be inherited or caught. The infectious agent is unknown, but the disease is associated with an abnormal protein which is also seen in scrapie in sheep (see **Prion**). Symptoms do not appear until months or years after infection. Scientists know the disease can be spread by accidental contact with contaminated materials. The Creutzfeldt-Jakob disease occurs throughout the world, affecting about 1 out of every 1 million people. It afflicts both men and women, mainly between the ages of 50 and 75. No treatment or cure has been discovered.

Crèvecoeur, Michel-Guillaume Jean de (1735-1813), was a French-born essayist who portrayed rural life in colonial America. His descriptions of the attitudes and hopes of the colonists persuaded many Europeans to settle in America.

Crèvecoeur was born near Caen, France. When he was 19 years old, he went to Canada to fight with the French during the French and Indian War. In 1769, he bought a farm near Chester, New York, U.S.A., and began his literary career.

Crèvecoeur wrote under the pen name of J. Hector St. John. He became best known for 12 essays collected in *Letters from an American Farmer* (1782), written to an imaginary friend in England. The essays describe such scenes as children coming home from school during a snowstorm and families fleeing an Indian massacre.

Crèvecoeur supported the British during the Revolutionary War in America (1775-1783). In his *Sketches of Eighteenth Century America* (published in 1925, after his death), he accused the patriots of greed and the abuse of power in their struggle for independence. Crèvecoeur served as French consul to the United States from 1783 to 1790 and spent the rest of his life in France.

Crewe and Nantwich (pop. 101,800) is a local government district in south Cheshire, England. The area is mainly agricultural in character, and dairy farming is important. The town of Crewe is a well-known railway junction, and has large railway workshops. Workers in the town also manufacture motor vehicles. A large in-



Crewel is a wool yarn used for embroidery. The yarn is stitched onto a plain cloth, following the design printed on the cloth.

dustrial estate has attracted new industries, including engineering and food processing. The historic town of Nantwich has many half-timbered buildings, and is a popular tourist centre.

See also Cheshire.

Crewel, also called *crewelwork*, is a form of embroidery done with woollen yarn. Most crewel has designs stitched on a background of plain, sturdy cloth. The yarn, which consists of two woollen threads twisted together loosely, is also called crewel.

Crewel can be used to create almost any design. Many crewel embroideries show flowers and vines arranged in graceful patterns. Crewelwork may include any embroidery stitch.

Historians believe the ancient Hebrews used crewel to decorate the Tabernacle, a tent in which they worshipped. During the A.D. 1000's or 1100's, French women stitched the Bayeux Tapestry, a famous crewel wall hanging. Crewel decorated curtains and upholstery in many American and English homes of the 1600's and 1700's. Today, many people stitch crewel pictures and other items.

Cribbage, also called *crib*, is a card game for two, three, or four people. Each player keeps score on a *cribbage board*, using two *pegs*. The object of the game is to *peg* (score) 121 points. The invention of the game is credited to Sir John Suckling, an English poet, during the 1600's.

When two people play, they *cut* (divide) the pack and the one with the lower card deals. Each player is dealt



in a **cribbage game**, the players keep their own score by moving two pegs on the special cribbage board.

six cards and places two of them face down. These cards form the *crib*, which is used at the end of the hand. The nondealer cuts the rest of the cards and turns up the top card of the lower part of the pack. This is the *turnup* or *starter*. If the turnup is a jack, the dealer pegs 2 points for *heels*.

The nondealer begins by laying down a card and calling its value. The dealer then lays down a card and adds its value to the first card. They continue until the value of the cards totals 31. The player who reaches 31 pegs 2 points. A player who cannot lay down a card without going beyond 31 must say "go." The other player then pegs 2 for *go* after playing as many cards as possible to score exactly 31, or 1 for a lesser total. Whenever a *go* occurs, the opponent of the one who last played begins a new count. When the players have used all their cards, they peg the total points for their hands.

In scoring, court cards count 10, the ace counts 1, and the others count according to their *index value* (number of pips). Points are scored both during the play and at the end of the hand. Each combination of 15 points and each pair counts 2 points. A *run* of three or more cards in sequence scores 1 for each card. Three cards of a kind count 6 and four of a kind count 12. Four cards of the same suit (or five, including the turnup) score a *flush*, worth 1 point per card. At the end of the hand, the nondealer's score is counted first. All players include the turnup in the count of their hands. A player holding a jack of the same suit as the turnup calls *1 for his nob* and pegs 1. The crib belongs to the dealer, and is scored in the same way, except that only five-card flushes count.

Crichton, James (1560-1582?), became known as the *admirable Crichton* because of his all-round learning. He was a good linguist, mathematician, and philosopher, a brilliant debater, a competent poet, and a fine horseman and swordsman. He is said to have been killed in a street brawl in Mantua, Italy.

After his death, the memory of his many-sided genius captured people's imaginations, partly as a result of Sir Thomas Urquhart's account of his career, *Discovery of a Most Exquisite Jewel* (1652). Crichton was born at Elick, in Dumfries and Galloway Region, Scotland.

Crick, Francis H. C. (1916-), is a British biologist. He shared the 1962 Nobel Prize for physiology or medicine with American biologist James D. Watson and biophysicist Maurice H. F. Wilkins, also of Great Britain. Crick and Watson built a model of the molecular structure of *deoxyribonucleic acid* (DNA), the substance that transmits genetic information from one generation to the next. The model, resembling a twisted ladder, is called the *double helix*. Later, Crick helped explain how DNA determines the development of living things. See Cell (The 1900's; picture: A model of a DNA molecule); Nucleic acid.

Originally a physicist, Crick helped develop radar during World War II (1939-1945). He began research work in molecular biology at Cambridge University in 1949. In 1976, he became a research professor at the Salk Institute in San Diego, California, U.S.A. Born in Northampton, England, Crick studied at London and Cambridge universities.

See also Science (picture: A ladderlike model of DNA).



Test matches between Australia and England have been held for more than a hundred years. The two teams play for the *Ashes* about every two years, alternately in Australia and England. Cricket is an important link between the two countries.

Cricket

Cricket is a game played with a bat and a ball by two teams of 11 players each. It is one of the most popular games in Britain and in many countries that once were British colonies. Cricket is played on a round or oval grass field. The action centres on a strip of ground, called the pitch, between two *wickets*. Each wicket consists of three wooden stumps and two sticks called *bails*, which rest on top of the stumps.

The teams take turns batting and fielding. A member of the fielding side called the *bowler* stands near one of the wickets. The bowler runs up to the wicket and *bowls* (delivers) the ball with a stiff-armed motion at the opposite wicket. The ball bounces once in front of the wicket on most deliveries. A fielder called the *wicketkeeper* stands behind the wicket.

Members of the batting side are called *batsmen*. A batsman called the *striker* stands at the far wicket, facing the bowler, and tries to hit the ball with a long, flatsided bat. If the ball knocks a bail off the wicket, the striker is out (dismissed). If the ball is hit into the field, the striker and a batsman called the *nonstriker*—a teammate at the opposite wicket—may try to score a run.

The batsmen score each time they run to the opposite wicket before a fielder can knock off a bail with the ball. Sometimes they can run back and forth several times before a fielder can return the ball. The next striker is the batsman who is at the wicket opposite the bowler when the ball is returned. The two batsmen continue to play until one of them is out. The batsman who is out is then replaced by a teammate. Runs are also scored for hits that reach or cross the field's boundary line. A major cricket match may last from three to five days or more. The team that scores the most runs wins.

The ground and equipment

The grounds vary in size. Most grounds on which official matches are played measure about 137 metres wide and 150 metres long. The wickets are 22 yards (20.12 metres) apart in the centre of the field. They stand opposite and parallel to each other. The area between the wickets is called the *pitch*.

Each wicket measures 9 inches (22.9 centimetres) wide. The stumps of each wicket are close enough together so the ball cannot pass between any two of them. The tops of the stumps stand 28 inches (71.1 centimetres) above the ground. The bails are 4 $\frac{1}{2}$ inches (11.1 centimetres) long and rest in grooves on the tops of the stumps. The bails do not rise more than $\frac{1}{4}$ inch (13 millimetres) above the stumps.

White lines made by chalk or lime mark certain boundaries called *creases*. A line called the *bowling crease* is drawn through the stumps of each wicket. It is 8 feet 8 inches (2.64 metres) long, with the middle stump of the wicket at its centre. A line called the *popping crease* is marked 4 feet (1.22 metres) in front of the bowling crease. The popping crease extends at least 6 feet (1.83 metres) on either side of the centre of the wicket but is considered to be unlimited in length. Lines called *return creases* are marked from each end of the bowling crease. The return creases extend forward to the popping crease and back at least 4 feet (1.22 metres) behind the bowling crease. However, the return creases are considered to be unlimited in length. The bowler must deliver the ball with some part of the front foot behind the popping crease. The back foot must be between the return creases.

Equipment. The rules of cricket do not specify the material to be used in making a cricket ball. The best balls have a cork centre wrapped with twine, and a



The fielding positions, above, are those that apply for a right-handed batsman.

leather cover. The ball must be between $8\frac{1}{16}$ and 9 inches (22.4 and 22.9 centimetres) in circumference, and it must weigh between $5\frac{1}{2}$ and $5\frac{3}{4}$ ounces (155.9 and 163 grams).

The bat cannot be more than 38 inches (96.5 centimetres) long nor more than $4\frac{1}{2}$ inches (10.8 centimetres) wide at any point. It must be made of wood. The bat has a round handle and a flat, bladelike hitting surface.

Cricket players may wear peaked caps or helmets, open-necked shirts, trousers, and spiked or crepe-soled shoes. Batsmen and wicketkeepers wear protective leg pads and gloves. Players who field close to the wicket may also wear such protective devices as shin-guards.

The game

A cricket match may consist of one or two *innings* by each team. In first-class cricket, all matches are two-innings matches. But one-day cricket in which each team has one innings, consisting of a limited number of overs, has become popular. Such matches are not considered to be first-class. In first-class cricket, a team's innings ends when 10 of the 11 players have been dismissed. But the captain of the batting side may declare the side's innings closed at any time.

Team captains toss a coin to decide who will bat first. After the first innings of a two-innings match, the captain whose team batted first may order the opposing side to *follow-on* if the opposing side is behind by a certain number of runs. The opposing team must then start its second innings immediately after its first innings. The opposing team may be ordered to follow on if it is be-

hind by 200 runs in a match of five days or more, by 150 runs in a three- or four-day match, by 100 runs in a two-day match, or by 75 runs in a one-day match. If the team that follows on scores a lower total in their two innings than their opponents scored in one, the team that batted first wins *by an innings*. If the team that follows on passes their opponent's total in their second innings, then the first side will bat again, taking the fourth innings instead of the third.

A team may also win by a certain number of wickets. A team wins by wickets if it takes the lead during its second innings and the opposing team has already batted twice. If the team takes the lead after four batsmen have been put out, for example, it wins by six wickets because six batsmen have remained not out. If a match is not won by an innings or by wickets, the outcome is expressed by the number of runs scored by each team.

Scoring. Most runs are scored by running from one wicket to the other. Each batsman must safely cross the opposite popping crease to score one run. Batsmen also score runs when they hit the ball out of the playing area, which is enclosed by the *boundary*. They score four runs when the ball rolls or bounces across the boundary line. They score six runs if the ball clears the boundary before hitting the ground.

Runs called *extras* or *sundries* may also be scored in various ways. Sundries include *byes*, *leg byes*, *wides*, and *no balls*. A bye is a run scored when the ball passes the batsman without touching the bat or any part of his body and without knocking off a bail. A leg bye is a run scored when the ball hits the striker anywhere but on the hands. A ball that hits the hands or gloves below the wrist is played as if it had hit the bat.

A wide ball is a delivery that the umpire rules is out of the batsman's reach. One run is automatically scored for a wide ball. A no ball may be called for certain violations of the rules. The main violations occur when (1) the bowler throws the ball instead of bowling it or (2) the bowler's feet are not in the proper position when the ball is delivered. A penalty of one run is scored for a no ball. But if a batsman hits a no ball and the batsmen score runs, these runs are counted instead of the penalty.

Dismissals. There are several ways to dismiss a batsman. The most direct way is by bowling a ball which dislodges a bail from the stumps. Batsmen are also out if they are *caught*—that is, if they hit a ball that is caught by a fielder before it bounces or that lands in a fielder's clothing without touching the ground. Either batsman may be *run out* when trying to score. A batsman is run out if a wicketkeeper or other fielder breaks the wicket with the ball while the batsman is between the popping creases. He is then said to be *out of his ground*. A batsman is out *stumped* if he is out of his ground when not attempting a run and the wicketkeeper removes a bail with the ball, or with the hand in which he is holding it. A batsman can also be out *LBW* (leg before wicket) if he prevents the ball from hitting the wicket with any part of his body except with his hands. A batsman is out *hit wicket* if, while playing at a ball, he breaks the wicket with his bat or with any part of his body or clothing, including his cap or helmet falling off. A batsman is also out if he hits the ball a second time except to keep it from hitting the wicket. *Obstructing the field* occurs

Ways to be out

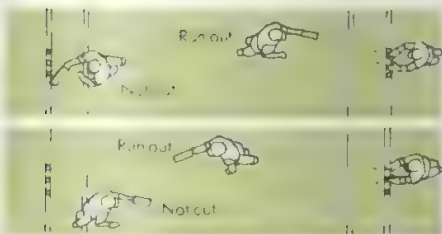
LBW (leg before wicket). The ball must be aimed at the wicket and hit the batsman's body. The batsman is not out if the ball hits the bat or hand first.



Stumped. The wicketkeeper must knock off a ball with the ball or with a hand while holding the ball when the batsman is out of the crease, but not running.



Bowled. The ball must knock a bail off the wicket either directly or after being hit by the batsman.



Run out. A fielder or the wicketkeeper must knock off a bail with the ball before the batsman completes a run. The run on which a player is run out does not count.



Caught. The ball must touch the bat or the hand holding it, then must be caught before it touches the ground.

when a batsman prevents a player from fielding the ball. If the umpire decides that the batsman's action was deliberate, he declares the batsman out. A batsman may be out *handled ball*, if he intentionally touches a ball in play with a hand that is not holding the bat.

Umpires make sure the game is played according to the rules, and they settle all disputes. One umpire stands behind the bowler's wicket to make decisions on whether the striker is caught or out LBW, and to rule on run outs at the bowler's end. A second umpire stands to the side of the striker's popping crease to rule on a stumping or run outs at that end.

The umpire at the bowler's end also decides whether the ball is in play. The ball is in play from the moment the bowler begins the run-up to the popping crease. The ball is *dead* (not in play) when (1) it is finally settled in the hands of the wicketkeeper or bowler, (2) it lodges in the clothing or equipment of a batsman or umpire, (3) it lodges in a fielder's helmet, (4) it has been called lost, (5) a boundary is scored, (6) a batsman is out, (7) a penalty is awarded after a fielder intentionally stops the ball with something other than the body, (8) the umpire calls "over" or "time," (9) the umpire suspends play because of an injury to a player, or (10) the umpire intervenes in a case of unfair play.

Playing cricket

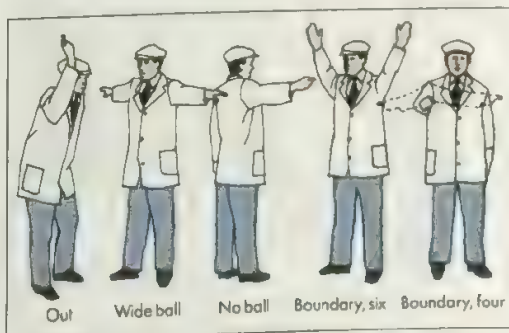
The batting side. The order in which a team's batsmen will bat is decided by the captain. After a batsman is out, a teammate replaces him until 10 players are out. One batsman always remains *not out*.

A batsman may hold the bat any way that is comfortable and effective. Batsmen should stand with their

weight evenly distributed and the feet slightly apart. Most batsmen stand with one foot on each side of the popping crease. One of the great skills of batsmanship is the ability to hit the ball so that it passes between the fielders.

The batting strokes may be divided into two categories, *forward play* and *back play*. Each may be used either (1) to attack and try to score runs or (2) defensively to protect the wicket. For both strokes, the batsman swings the bat back in a movement called the *back-lift*, then brings it forward and down past the feet to hit the ball.

On a forward stroke, the batsman moves the front foot forward near the path of the ball, putting his weight on the front foot. When facing a slow bowler, the batsman may take two or three steps towards the ball, rather



The umpires stand at either end of the pitch. They use arm signals to indicate their decisions to players and spectators.



Batting strokes are used either to try to score runs or to protect the wicket. The batsman on the left uses a forward defensive stroke. On the right, he uses a back stroke to keep the ball from hitting the wicket.

than one long step. A forward stroke is better for a ball that bounces near enough to the batsman to be hit on the *half-volley*—that is, as soon as it bounces off the ground. Forward strokes are usually made with the bat pointed down—that is, with an angled bat. In this way, the ball is played along the ground and not in the air, where it may be caught.

The back stroke is better for a ball that bounces so far in front of the batsman's wicket that the batsman can see which way the ball moves after it hits the ground. When playing defensively, the batsman brings the back leg into the path of the ball and points the bat down. There should be no space for the ball to pass between the bat and the batsman's body. In attacking back play, batsmen use a variety of strokes, depending on where the ball bounces and in what direction it moves. For example, they may swing the bat at an angle to the path of the ball with a *hook* or *cut* stroke. Another stroke called the *back cut* is played off the back foot to a ball wide of the off stump. The *square cut* sends the ball square of the batsman (roughly at right angles to him). The *late cut* sends



The bowler looks over his shoulder at the point on which he wants to bounce the ball. He then brings his arm over keeping it stiff to prevent jerking, and follows through after the release

the ball fine (at a slanting angle behind the wicket).

As soon as the bowler delivers the ball, the nonstriker should be *backing up* (moving toward the opposite wicket) and ready to run. Batsmen do not have to try to score if the ball is hit. On most hits that go in front of the wicket, the striker decides whether it is possible to score. If it looks like both batsmen can safely reach the opposite popping crease, the striker calls to the nonstriker that they should run. When the ball goes behind the wicket, the nonstriker decides whether the batsmen should try to score. Misunderstanding between the batsmen is the main cause of run outs.

The fielding side consists of the bowler, the wicket-keeper, and nine other fielders. The other fielders' positions vary in name and location. The most common positions are shown in the diagram that appears in this article. The captain directs the fielders to various positions.

After the bowler has delivered a certain number of balls, the umpire calls "over." An over consists of either six or eight legitimate deliveries. Wide balls and no balls do not count in the total. After each over, the striker becomes the nonstriker and the nonstriker becomes the striker. Two successive overs cannot be bowled from the same end in one innings. In *limited-over* cricket, the game ends after a certain number of overs rather than after one or two innings.

Good bowling is based on coordinated body, arm, and shoulder motion. The run-up to the bowling crease is designed to give the bowler enough power and balance to bowl the ball at the desired speed. At the final stride, a right-handed bowler's left shoulder should point toward the batsman. When the bowler's left foot has swung forward, the right shoulder should move forward and point in the direction the ball will travel. The bowler's wrist must be loose and the hand cocked back before releasing the ball. For the most power, the bowler continues the arm motion after the release.

Bowlers try to deliver the ball so it bounces a short distance in front of the batsman. Such a delivery is difficult to hit because the batsman is uncertain whether to play forward or back. In addition, bowlers try to get batsmen out by changing the direction of the ball. Bowlers change the direction by controlling the ball's speed and by gripping and spinning the ball in special ways. They can thus make the ball *curve* (change direction in flight) or *break* (change direction after it bounces).

The international administration of cricket

Traditionally, the chief administrative body for cricket is the Marylebone Cricket Club (MCC), in London, a private club with about 18,000 members. The MCC was founded in the late 1700's. Since 1788, it has made and published the laws of cricket. It still holds the copyright on the laws of the game and controls their revision. It also does its best to uphold the spirit of the game.

The highest level of cricket is found in international competitions called *test matches*. Official tests are played between teams representing Australia, England, India, New Zealand, Pakistan, Sri Lanka, and the West Indies. These countries are full members of a body called the International Cricket Council (ICC), which meets annually to organize the year's test match programme and to discuss topics relating to the game.

The ICC was originally founded in 1909 as the Imperial Cricket Conference, representing three countries: England, Australia, and South Africa. India, New Zealand, and the West Indies joined in 1926, and Pakistan joined in 1952. When South Africa left the Commonwealth in 1961, its membership of the ICC ceased, although it continued to play test cricket until 1970 (see Commonwealth of Nations). In 1965, the ICC was renamed the International Cricket Conference and agreed to admit cricketing countries that did not play test matches as associate members. Ceylon (now Sri Lanka), Fiji, and the United States were the first associate members. In 1989, the ICC was renamed the International Cricket Council. It then consisted of two foundation members (England and Australia), five full members (India, New Zealand, Pakistan, Sri Lanka, and the West Indies), and 18 associate members. South Africa was readmitted to the ICC in 1991.

The World Cup. The ICC is in charge of the overall administration of the four-yearly World Cup cricket competition, though the ruling bodies of the countries where the competitions take place are responsible for local arrangements. The World Cup was inaugurated in 1975 and the first three tournaments took place in England. In 1975, the World Cup was contested by the then six test match-playing countries, plus East Africa and Sri Lanka. The West Indies beat Australia in the final. In 1979, the World Cup, contested by the same teams except that Canada played instead of East Africa, was again won by the West Indies, who beat England in the final.

In 1983, when Zimbabwe played instead of Canada, India were the victors, beating the West Indies. The 1987 World Cup, played by the same eight countries as in 1983, took place in Pakistan and India. In the final, Australia beat England. The fourth World Cup competition was held in 1992 in Australia and New Zealand. The eight countries which had competed in 1987 were joined by South Africa. The 1992 competition was won by Pakistan who beat England in the final.

Cricket in the United Kingdom

Cricket is played throughout the United Kingdom. But it is most popular in England, where it originated. Cricket was probably played as early as the 1300's. It became a major sport in the 1700's. In its earliest forms, the ball was bowled underhand, and bats were shaped like hockey sticks. In the mid-1800's, overarm bowling became legal, and batsmen began using bats like those of today. In 1859, the first overseas cricket tour took place. An English team went to North America and played against teams in Canada and the United States.

Organization. Cricket is played as an organized game at many levels. Test matches and similar contests, such as one-day international matches, are played against the other cricketing countries. The test and county games together comprise first-class cricket. The other levels of cricket include school, club, and village matches.

Test cricket evokes great interest, especially the matches between the "old enemies," England and Australia. The rivalry of these two sides goes back to 1877. But the competitive spirit is just as intense when England plays test sides from other countries.

County cricket is supported largely by sponsorship,

fund-raising campaigns and revenue from test matches and other major games. A total of 18 county cricket clubs play in the Britannic Assurance County Cricket Championship. Seventeen of the clubs are from England and one, Glamorgan, is from Wales. An additional 20 clubs play in the Minor Counties Championship. County matches were once played over three days, but a four-day match programme was introduced starting in 1993. Test matches are played over five days. One-day limited-over games have also proved popular and have attracted sponsorship.

The Natwest Trophy (60 overs each side) is a knockout competition for all the First-Class counties, 13 Minor Counties League sides, and national sides from Ireland and Scotland. The final takes place at Lord's Cricket Ground, in London. The competition was founded as the Gillette Cup in 1963. Sponsorship passed to the National Westminster Bank in 1981.

The Benson & Hedges Competition (55 overs each side) is another knockout contest involving the First-Class county sides, a Minor Counties XI, a Combined Universities team, and Scotland. The competition dates from 1972. The Benson and Hedges final also takes place at Lord's.

The Sunday League (40 overs each side) is a limited-overs league played on Sundays. The League was founded as the John Player Special League in 1969. Refuge Assurance took over the sponsorship in 1987. Since 1988, the top four counties in the League have played an end-of-season 40-over knockout competition for the Refuge Assurance Cup. However, Refuge Assurance's sponsorship ended at the close of the 1991 season.

Women's cricket has been popular for many years and has recently developed rapidly. Its governing body is the Women's Cricket Association, founded in 1926. A women's test side plays international matches.

Britain's best-known cricket ground is probably Lord's Cricket Ground at St. John's Wood, London. It is the home ground of the Middlesex county side and is a venue for test matches and other regular features. Lord's is British cricket's administrative headquarters.

Test matches are played at other famous county grounds besides Lord's. They include Old Trafford, Manchester (home of the Lancashire side); Headingley, Leeds (Yorkshire's home ground); Trent Bridge, Nottingham (Nottinghamshire's home ground); Edgbaston, Birmingham (Warwickshire's home ground); and the Kennington Oval, in south London (Surrey's home ground).

Administration. Since 1969, cricket's chief administrative body, the Marylebone Cricket Club (MCC), has shared its administrative role in British cricket with the Test and County Cricket Board (TCCB) and the National Cricket Association (NCA). The TCCB controls all first-class cricket throughout the country, and the NCA controls all other formal cricket. The MCC, the TCCB, and the NCA together make up the Cricket Council.

The Cricket Council is now the governing body of English cricket. The TCCB's duties include the selection of test sides. The board appoints the selectors who choose the team to play in each individual test match.

The NCA, which expanded its authority and activities in the 1970's, has benefited greatly from commercial sponsorship. One of its important duties is to supervise coaching schemes for young players.

Australia versus England: The History of the Ashes

Season	Venue	Result	Season	Venue	Result
1876-1877	Australia	Australia won 1 test match; England won 1 test match	1934	England	Australia 2; England 1; 2 drawn
1878-1879	Australia	Australia 1	1936-1937	Australia	Australia 3; England 2
1880	England	England 1	1938	England	Australia 1; England 1; 2 drawn; 1 abandoned*
1881-1882	Australia	Australia 2; 2 drawn	1946-1947	Australia	Australia 3; 2 drawn
1882	England	Australia 1	1948	England	Australia 4; 1 drawn
1882-1883	Australia	Australia 2; England 2	1950-1951	Australia	Australia 4; England 1
1884	England	England 1; 2 drawn	1953	England	England 1; 4 drawn
1884-1885	Australia	England 3; Australia 2	1954-1955	Australia	England 3; Australia 1; 1 drawn
1886	England	England 3	1956	England	England 2; Australia 1; 2 drawn
1886-1887	Australia	England 2	1958-1959	Australia	Australia 4; 1 drawn
1887-1888	Australia	England 1	1961	England	Australia 2; England 1; 2 drawn
1888	England	England 2; Australia 1	1962-1963	Australia	Australia 1; England 1; 3 drawn
1890	England	England 2; 1 abandoned*	1964	England	Australia 1; 4 drawn
1891-1892	Australia	Australia 2; England 1	1965-1966	Australia	Australia 1; England 1; 3 drawn
1893	England	England 1; 2 drawn	1968	England	Australia 1; England 1; 3 drawn
1894-1895	Australia	England 3; Australia 2	1970-1971	Australia	Australia 2; 4 drawn; 1 abandoned*
1896	England	England 2; Australia 1	1972	England	Australia 2; England 2; 1 drawn
1897-1898	Australia	Australia 4; England 1	1974-1975	Australia	Australia 4; England 1; 1 drawn
1899	England	Australia 1; 4 drawn	1975	England	Australia 1; 3 drawn
1901-1902	Australia	Australia 4; England 1	1976-1977	Australia	Centenary test† Australia won
1902	England	Australia 2; England 1; 2 drawn	1977	England	England 3; 2 drawn
1903-1904	Australia	England 3; Australia 2	1978-1979	Australia	England 5; Australia 1
1905	England	England 2; 3 drawn	1979-1980	Australia	Australia 3†
1907-1908	Australia	Australia 4; England 1	1980	England	Centenary test† drawn
1909	England	Australia 2; England 1; 2 drawn	1981	England	England 3; Australia 1; 2 drawn
1911-1912	Australia	England 4; Australia 1	1982-1983	Australia	Australia 2; England 1; 2 drawn
1912	England	England 1; 2 drawn	1985	England	England 3; Australia 1; 2 drawn
1920-1921	Australia	Australia 5	1986-1987	Australia	England 2; Australia 1; 2 drawn
1921	England	Australia 3; 2 drawn	1987-1988	Australia	Australian bicentenary test† drawn
1924-1925	Australia	Australia 4; England 1			Australia 4; 2 drawn
1926	England	England 1; 4 drawn			Australia 3; 2 drawn
1928-1929	Australia	England 4; Australia 1			Australia 4; England 1; 1 drawn
1930	England	Australia 2; England 1; 2 drawn			
1932-1933	Australia	England 4; Australia 1			

*Not a single ball was bowled in the abandoned matches in 1890, 1938 and 1970-1971

†According to the ICCB the Ashes were not at stake in these matches

History. The origins of cricket are not known precisely, but it was probably played as early as the 1300s. It was certainly well established by the time of the Tudor monarchs (1485-1603).

Cricket's development seems to have prospered in the weald of Surrey, Kent, and Sussex. Regular organized matches were played by the Hambledon Club on Broadhalfpenny Down between 1750 and 1787. The MCC was founded in 1787 and won early acceptance as the game's governing body.

The first test match took place at Melbourne, Australia, in 1877, when an Australian side beat James Lilly-white's XI by 45 runs. Since 1882, England and Australia have played a regular series of test matches for the *Ashes*. This term was first used after Australia had beaten England in a match in London. After that defeat, an English newspaper, the *Sporting Times*, printed a mock obituary notice, written by Shirley Brooks: "In affectionate remembrance of English Cricket, which died at the Oval, 29th August 1882. Deeply lamented by a large circle of sorrowing friends and acquaintances. R.I.P. N.B. The body will be cremated, and the ashes taken to Australia."

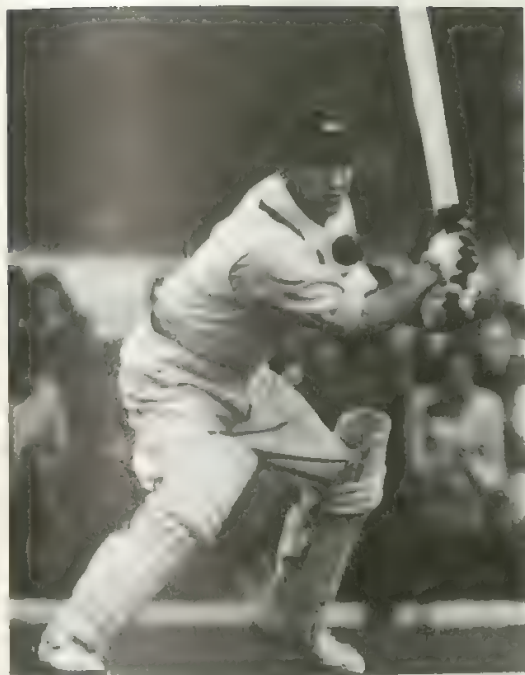
The following winter, Ivo Bligh, afterwards Lord Darnley, went to Australia. He promised to try to bring back the "ashes" of English cricket. His team won. Some Australian women in Melbourne burned a stump used in the third game and put the ashes in a small urn, which they presented to the English captain. When Lord Darnley died in 1927, the urn, by a bequest in his will, was

given to the MCC. It is now displayed in the MCC Museum behind the pavilion at Lord's Cricket Ground.

The elegance of Edwardian cricket matches was shattered by the effects of World War I, and the game's protracted period of recovery spanned the 1920s. By the 1929-1930 winter season, the MCC was strong enough to send two test sides to tour New Zealand and the West Indies. England's 1932-1933 tour to Australia, under D. R. Jardine, was the controversial *bodyline* bowling series. For a description of this series and its effects on Australian-English relations, see the section on *Cricket in Australia (History)* later in this article.

The 1960s, 1970s and 1980s saw many changes, including the development of one-day cricket; the introduction of commercial sponsorship; the proliferation of one-day international matches beyond the usual test series; a decline in attendance at county championship matches, and an increase in the number of overseas players at first-class level in English cricket. 1977 saw the emergence of World Series Cricket (WSC), backed by Kerry Packer, an Australian television executive. Packer's enterprise brought a brash commercialism to cricket. WSC was disbanded in 1979, but its effects continued.

In the late 1980s and early 1990s the ICCB introduced several changes aimed at raising the standards of first-class cricket among players eligible to play for England. These changes included the introduction of four-day cricket, the imposition of penalties for pitches considered to be substandard, and the limitation of only one overseas player per county club.



Sir Leonard Hutton, one of England's most outstanding opening batsmen, scored 364 in a test against Australia (1938).

Outstanding cricketers. W. G. Grace heads the list of famous English batsmen. Another batsman of outstanding quality was C. B. Fry. Sir Jack Hobbs scored 197 centuries during his career. Frank Woolley was a left-hander of exquisite skill. Wally Hammond was a batsman of grace and power. Sir Leonard Hutton won fame for his record-breaking 364 at the Oval against Australia in 1938. Batsmen of the era since World War II include Denis Compton, Peter May, Colin Cowdrey, Ted Dexter, Geoffrey Boycott, David Gower, and Graham Gooch. Ian Botham became one of the finest all-rounders of all time.

Among bowlers, Sidney Barnes holds pride of place with many experts. Others include Maurice Tate, Harold Larwood, Hedley Verity, Alec Bedser, Brian Statham, and Freddie Trueman. Trueman was the first bowler to take more than 300 wickets in tests. Notable wicket-keepers were Godfrey Evans and Alan Knott.

Cricket in Australia

Cricket has been one of the most popular sports in Australia for more than a hundred years. Australia is one of the world's leading nations in international cricket.

The largest crowd ever to watch a cricket test match anywhere in the world totalled 250,534 over six days of the third test of the 1936-1937 series between Australia and England. The match took place at the Melbourne Cricket Ground. The largest crowd ever to watch a single day's play anywhere in the world was 90,800. Again the venue was Melbourne, but this time the teams were Australia and the West Indies.

Organization. Cricket is played at all levels in Australia. Every school with boys has cricket teams. The

states of Australia compete for the Sheffield Shield. The Sheffield Shield was given by Lord Sheffield, an English patron of the 1890's, for competition among the Australian states. The shield bears the coat of arms of Sheffield and Australia. It dates from the 1892-1893 season, when New South Wales, South Australia, and Victoria competed. Victoria won. Queensland was admitted in 1926, Western Australia in 1947, and Tasmania in 1977.

Test matches are played between Australia and England for the *Ashes* about every two years, alternately in England and in Australia. Australia also plays against India, Pakistan, the West Indies, Sri Lanka, and New Zealand. Until 1970, Australia also played against South Africa.

Women's cricket is also popular. A women's match took place between New South Wales and Victoria in 1891. But the Australian Women's Cricket Council was formed 40 years later, in 1931, with New South Wales, Victoria, and Queensland as the foundation members. Interstate games were played, and in 1934-1935, an English team visited Australia. Since then, several series have been played both in Australia and abroad.

Administration. The Australian Cricket Board of Control (ACB) is the representative body of cricket in Australia. It was founded in 1905.

History. The first matches in Australia that are definitely known about took place in Sydney in 1803. But casual games were undoubtedly played before that time. By 1840, cricket had taken a firm hold in Sydney.

Tasmania introduced cricket in the early days of settlement. But the exact year is unknown.



Sir Donald Bradman, one of Australia's greatest cricketers, captained his country's test side from 1936 to 1948.

Wickets were pitched on Batman's Hill soon after John Batman selected the site of Melbourne. In November 1838, three years later, the Melbourne Cricket Club was formed. It wielded great influence over Australian cricket for several years, though it worked in harmony with the Sydney Cricket Ground to arrange early tours. In 1838, the first meeting was called in South Australia to form a cricket club. The South Australian Cricket Association was formed in 1871.

Settlement in Western Australia was made in 1829. Although cricket was played soon afterward, it was not regarded seriously. It was not until 1893 that a Western Australian team toured the eastern colonies.

A challenge by the Melbourne Cricket Club in 1856 led to the first intercolonial game, with New South Wales defeating Victoria by three wickets.

In 1861, a Melbourne catering firm sponsored a tour of Australia by 12 professionals from England, under the captaincy of H. H. Stephenson. The team played against the odds of 15, 18, and sometimes 22 Australian players and lost only 2 of 15 matches. The sponsors made a large profit. This encouraged further visits, and in 1873, W. G. Grace captained a team to Australia.

In 1868, Charles Lawrence took a team of Aborigines to England. His team won 14 matches, lost 14, and drew 19. The best performance by the visitors was given by Twopenny against Hampshire. Twopenny took 9 wickets for 9 runs, 8 of them bowled, and then caught the 10th batsman. He took 5 for 12 in the second innings. Dave Gregory captained a white team to England from Australia in 1878. Of 41 matches, the visitors won 19, lost 7, and drew 15.

Test matches with England began after James Lillywhite brought out the fourth English team in 1876. But after New South Wales, with 15 players, twice beat the English team of 11 players, and Victoria, also with 15 players, once beat England, it was decided to play on even terms with 11 men a side.

After taking his team to New Zealand, Lillywhite brought his men to Melbourne, where, on March 15,

1877, the first test match between Australia and England was begun. It lasted for three days, and Australia won by 45 runs. The only century of the match was made by Charles Bannerman, who played for Australia. He retired hurt after scoring 165. A second test match was played in 1877, also in Melbourne. England won by four wickets. This was the origin of what became one of the world's most famous sporting competitions. From 1882, the regular test matches between Australia and England were played for the Ashes.

Cricketing rivalry between the countries was always keen. In the 1932-1933 season, when England devised a *leg theory* attack to curb the great Australian batsman Don Bradman, it threatened relations between Australia and Britain. The series was held in Australia. Captaining England was D. R. Jardine, with fast bowlers Harold Larwood, Bill Voce, G. O. B. Allen, and W. E. Bowes. The leg side was packed with fielders and the fast bowlers pitched balls that bounced dangerously toward the batsmen. The attack was known as *bodyline*.

Several Australian batsmen suffered injuries from flying balls. W. M. Woodfull, the Australian captain, was struck severely over the heart. Wicketkeeper Bert Oldfield was knocked unconscious when he was struck on the head by a ball from Larwood. Woodfull made the famous remark: "There are two teams out there and one of them is playing cricket."

In the third test, in Adelaide, both Woodfull and Oldfield were injured. The Australian Board of Control sent a cable to the MCC, expressing the opinion that the attack was unsportsmanlike and stating that, unless the tactics were altered, friendly relations between the two countries would be greatly impaired. The MCC replied that it had confidence in the team, the captain, and the players, and offered to cancel the tour if the board so wished. The tour continued, but Larwood retired at the end of it because of the unfavourable criticism.

Outstanding cricketers. Many experts on cricket regard Don Bradman as the greatest batsman of all time. He played in 52 tests, scoring 6,996 runs, with an unri-



Ian Botham (England)



Dennis Lillee (Australia)



Richard Hadlee (New Zealand)

valued average of 99.94. Many other batsmen have scored more than 5,000 runs in test cricket. In 1993, Allan Border reached 10,200 runs in test cricket passing the total of Sunil Gavaskar of India.

Fred Spofforth was the earliest of Australia's great fast bowlers. He became known as the *demon*. Australia has also produced such great fast bowlers as Ray Lindwall and Dennis Lillee. Famous slow bowlers include Richie Benaud, Clarrie Grimmett, and Arthur Mailey. All-rounders include Jack Gregory and Keith Miller, while wicketkeepers include Don Tallon and Rodney Marsh.

Cricket in South Africa

Cricket is a major game in South Africa and the first recorded match, between teams made up of army officers, took place in 1808.

Organization. From 1889, the chief internal competition was the Currie Cup, but in 1991 the competition was reorganized and the ruling body announced that, from the 1992-1993 season, the domestic competition would be known as the Castle Cup.

Administration. The ruling body, founded in 1991, is the United Cricket Board of South Africa. It amalgamates the ethnically separate cricket organizations previously set up under apartheid (see *Apartheid*).

History. The first matches between South Africa and England given test match status were played in 1888-1889. Due to political controversy, however, South Africa did not play any official test matches between 1970 and 1991. Its return to international cricket was marked by three one-day internationals played in India in November 1991, followed by its participation in the World Cup competition in 1992. South Africa then played its first test match for 21 years against the West Indies in Barbados in April 1992. South Africa has produced many great players, including batsmen Graeme Pollock and Barry Richards, spin bowler Hugh Tayfield, and all-rounder Mike Procter. The South African Basil D'Oliveira moved from Cape Town and played for Worcestershire and England with great success.

Cricket in New Zealand

Cricket is a popular game throughout New Zealand. The first-class sides are Auckland, Canterbury, Central Districts, Northern Districts, Otago, and Wellington.

Organization. From 1906, New Zealand's first-class teams competed in a challenge competition, the Plunket Shield. It was named after a governor-general of New Zealand. The competition became a league in 1921-1922. In 1974-1975, the Plunket Shield was replaced by the Shell Trophy, sponsored by the Shell Oil Company. Each team plays eight league matches. New Zealand's limited-overs competition was introduced in 1971-1972.

Administration. The top cricketing organization in New Zealand is the Cricket Council's Board of Control.

History. New Zealanders have played cricket since the 1830's, and first-class cricket began in the 1860's. The first New Zealand team to play overseas competed in Australia in 1898. But New Zealand did not achieve test status until 1929-1930, when New Zealand played a touring MCC side. The only other test team to play New Zealand before World War II was South Africa.

New Zealand played its first test against Australia in 1945-1946. But, apart from this one game, New Zealand and Australia did not meet in a test match series until 1973-1974. Australian cricket overshadowed New Zealand cricket for many years, but New Zealand emerged as a major international team in the 1980's. They owed much to such batsmen as Glenn Turner and Martin Crowe, and to the all-rounder Sir Richard Hadlee.

Cricket in India

Cricket arouses great enthusiasm in India. It has captured the imagination of many people, especially since India won the World Cup in 1979.

Organization. The main competition is the Ranji Trophy, which was founded in 1934 and named in memory of the great cricketer Kumar Shri Ranjitsinhji, who later became the Jam Sahib of Nawanagar. Major centres of cricket include Bombay, whose team has achieved the



Sunil Gavaskar (India)



Imran Khan (Pakistan)



Vivian Richards (West Indies)

greatest success in the Ranji Trophy, Delhi, Calcutta, Madras, and other state capitals.

Administration. The supreme cricketing organization is the Board of Control for Cricket in India (BCCI).

History. Old Etonians (former pupils of Eton College, England) played against Parsis in India as early as 1784 and the Calcutta Club, once regarded as India's MCC, was formed in 1792. India's first great cricketer, K. S. Ranjitsinhji, played in England for Cambridge University, for Sussex, and in 15 test matches for England. The first Indian side to have first-class status toured England in 1911, but India did not achieve test match status until 1932. Great Indian players include the batsman Sunil Gavaskar, the all-rounders A. H. ('Vino') Mankad and Kapil Dev, and several great spin bowlers, including Bishan Bedi and B. S. Chandrasekhar.

Cricket in Pakistan

Pakistan has rapidly achieved a considerable reputation in world cricket. In 1992, Pakistan won the World Cup when they beat England in the final.

Organization. The chief first-class cricket competition is the Qaid-i-Azam Trophy, which was introduced in 1953-1954. The Wills Cup, dating from 1980-1981, is the leading limited-overs competition. The main cricketing centre is Karachi.

Administration. The supreme body for cricket is the Board of Control for Cricket in Pakistan (BCCP).

History. Pakistan gained test match status in 1952-1953, when it played a three-match series against India, winning one game, losing one, and drawing the other. Since then Pakistan has had an impressive record. Its great batsmen have included three brothers, Hanif Mohammad, Mushtaq Mohammad, and Sadiq Mohammad. Zaheer Abbas and Javed Miandad Khan were other fine batsmen. Imran Khan became one of cricket's greatest all-rounders, while Abdul Qadir's spin bowling has delighted spectators around the world.

Cricket in the West Indies

The West Indies have become known for their often spectacular cricket. They were once regarded as brilliant but inconsistent. But in the 1970's and 1980's, they dominated world cricket, winning the World Cup in both 1975 and 1979.

Organization. Six teams—Barbados, Guyana, Jamaica, Leeward Islands, Trinidad and Tobago, and Windward Islands—compete in the Caribbean Regional Cricket Tournament. This tournament was founded in 1965-1966 and was sponsored by Shell. The Shell Shield was replaced by the Red Stripe Cup after the 1986-1987 season. The six teams also compete in a limited-overs competition, the Geddes Grant Shield.

Administration. The supreme cricketing authority is the West Indies Cricket Board of Control (WICBC).

History. Cricket began in the West Indies in about 1800. By 1863, Barbados, Jamaica, Trinidad, and British Guiana (now Guyana) had cricket clubs. In 1886 and 1887, teams from the West Indies exchanged visits with teams from Canada and the United States. The first Triangular Tournament was staged in 1892-1893 between Demerara (Guyana), Barbados, and Trinidad, but the great distances between the islands made it impossible for Jamaica, which also had a good side, to compete.

Seven English sides toured the West Indies before World War I and the first West Indies team visited England in 1900. They were granted first-class status on a return visit in 1906.

Test match status was gained in 1928. Despite the brilliance of two players, the batsman George Headley and the all-rounder Sir Learie Constantine, the West Indies were at first regarded as better players at home than overseas. After World War II, the West Indies produced many great players, including Sir Frank Worrell and Sir Garfield (Gary) Sobers. During the 1980's, the West Indies, under Clive Lloyd and later Vivian Richards, dominated world cricket. Their success was based on a bowling attack consisting of four fast bowlers. Great fast bowlers of this period included Andy Roberts, Joel Garner, Michael Holding, and Malcolm Marshall.

Cricket in Sri Lanka

The British introduced cricket into Ceylon (now Sri Lanka) in the 1820's, and a cricket club was formed in Colombo in 1832. Sri Lanka became a full member of the International Cricket Conference (now the International Cricket Council) in 1981, and it gained test match status in 1982-83. However, the internal strife on the island led to the cancellations of several projected tours and this proved a major setback in the development of Sri Lankan cricket.

Cricket in other countries

Cricket also flourishes in Zimbabwe, which has played in international cup matches, and was granted test match status in 1992. Cricket is also played in many other parts of the world, including Argentina, Bangladesh, Bermuda, Canada, Denmark, Hong Kong, East Africa, Fiji, Gibraltar, Israel, Kenya, Malaysia, the Netherlands, Papua New Guinea, Singapore, the United States, and West Africa. All of these have representatives on the International Cricket Council.

Related articles in *World Book* include:

Barnes, Sidney F.	Hutton, Sir Leonard
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Botham, Ian	Larwood, Harold
Bradman, Sir Donald	Lillee, Dennis
Chappell (family)	Lloyd, Clive
Crowe, Martin	Marsh, Rodney
Fry, Charles B.	May, Peter B. H.
Gavaskar, Sunil	Richards, Viv
Gower, David	Simpson, Bobby
Grace, W.G.	Sobers, Sir Garfield
Gregory, Jack	Spooforth, Fred
Hadlee, Sir Richard	Tate, Maurice
Hammond, Walter R.	Trueman, Freddie
Harvey, Neil	Trumper, Victor T.
Hassett, Lindsay	Woodfull, Bill
Hobbs, Sir John	

Questions

- What is the length of a cricket pitch?
- Which country has a competition for the Ranji Trophy?
- How can a batsman be out *handled ball*?
- Which cricket team won the World Cup twice?
- What is a follow-on?
- What are extras?
- What is the popping crease?
- Which player finished his test match career with a batting average of 99.94?

Cricket is a type of jumping insect related to the grasshopper. Crickets differ from grasshoppers in several ways. Crickets have a long, needlelike *ovipositor* that deposits eggs. The wings of most crickets lie flat over each other on top of their backs. Other crickets have only tiny wings or are wingless. The slender antennae are much longer than the body in most kinds of crickets.

Crickets are well known for their songs. These songs are produced primarily by the males. Each kind of cricket has a different song, usually trills or a series of chirps. Crickets produce sound by rubbing their two front wings together. They hear sound with organs in their front legs. Their songs help male and female crickets find each other.

Crickets are commonly found in fields and on waste ground. Sometimes crickets enter houses. Crickets eat plants and the remains of other insects.

The best-known crickets are *house crickets* and *field crickets*. These black or brown insects are about 2.5 centimetres long. *Tree crickets* are pale-coloured insects. They live on trees and shrubs and feed on small insects called *aphids*. Male tree crickets sing in chorus. They have a high-pitched song. The *giant king cricket* of Australia is about 7 centimetres long. The males have a large head and large jaws. Giant king crickets live in ants' nests and eat ants' young. *Mormon crickets*, *camel (cave) crickets*, *mole crickets*, and *Jerusalem crickets* are not considered true crickets (see *Mole cricket*; *Mormon cricket*).

Scientific classification. Crickets are in the order Orthoptera and the cricket family, Gryllidae.

See also **Grasshopper**; **Insect** (picture: The "ears" of a cricket).

Crime is a term that refers to misconduct forbidden by law. Murder—also called *homicide*—is a crime in all countries. Other crimes include stealing a car, resisting arrest, possessing or selling illegal drugs, appearing nude on a public street, driving while under the influence of alcohol, and robbing a bank.

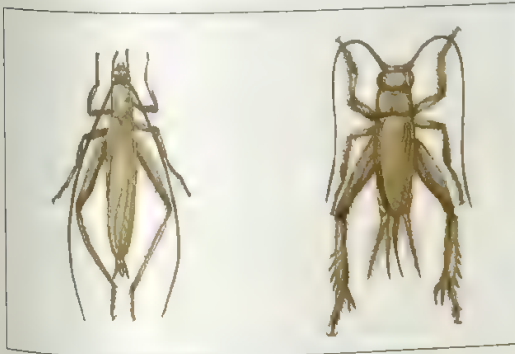
The list of acts considered crimes is constantly changing. For example, people are now no longer charged with witchcraft, though many were accused of that crime during the 1600's and 1700's. Today, it is becoming a serious crime to pollute the air and water. Pollution caused few problems and received little attention in preindustrial times.

From a legal standpoint, a crime is a violation of the *criminal law*. Such law deals with actions considered harmful to society. On the other hand, most harmful acts causing injury to another person are violations of the *civil law*. Some overlapping occurs in this classification. For example, murder and rape are committed against individuals, but the law considers them crimes because they threaten society. For this reason, a crime is regarded as an offence against the state.

An act is viewed as a crime if enough evidence exists to make a police officer, a prosecutor, or a judge believe that a violation of criminal law has taken place.



The field cricket, above, is known for its loud, chirping song. It grows to about 2.5 centimetres long.

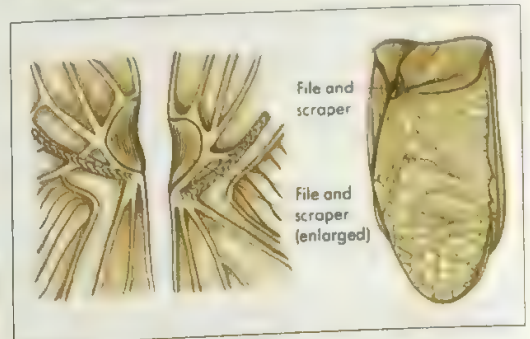


Tree cricket

House cricket



The camel cricket lives in caves and hollow trees.



The organs with which the cricket "sings." At the right are shown the cricket's front wings, folded along its back so that the right wing nearly covers the left. On the left, portions of the wings are shown separated, with the sound-producing organs enlarged. Each wing has a "file," or thickened vein with cross-ridges, and a "scraper," or hard, sharp-edged portion. The scraper of either wing may be rubbed against the file of the other wing to produce the mating call.

However, the law does not consider accused people to be criminals unless a judge or jury finds them guilty. A criminal may be imprisoned or receive some other punishment, according to the laws of the community in which the crime was committed or the trial was held.

A person who commits any crime is called a criminal. But the term is sometimes used only for a person who commits such a serious crime as murder or robbery. At other times, the term refers only to habitual criminals.

The study of criminal behaviour is called *criminology*, and experts in this field are called *criminologists*. Criminologists study crime and criminals for various reasons. They may try to determine where, when, and why different types of crime occur. Criminologists also seek the relationships between criminals and the victims, as well as the most effective ways to prevent crime. See *Criminology*.

Types of crimes

Crimes may be classified in various ways. For example, they sometimes are grouped according to the seriousness of the offence. For statistical purposes, many governments divide crimes into offences against people, against property, and against public order or public morality. Some social scientists classify crimes according to the motives of the offenders. Such crimes might include economic crimes, political crimes, and crimes of passion. Other important kinds of crime include organized crime and white-collar crime.

Crimes are often divided between acts that most people would consider evil and acts that lawmakers decide should be regulated in the interest of the community. The first group includes such major crimes as arson, assault, burglary, kidnapping, murder, rape, robbery, and theft. The second group of crimes includes violations of income tax laws, liquor licensing regulations, pure food and drug laws, and traffic laws. Most of the crimes in the first group have long been forbidden by English *common law*, and they usually involve severe punishments (see *Common law*). Offences in the second group are called *statutory offences* and are generally punished by fines or court orders.

Different countries classify crimes in different ways. In the United Kingdom, for example, there are two main classes of crime: *indictable offences*, which are serious crimes; and *summary offences*, which are less serious. In most cases, a person accused of an indictable offence is tried by a judge and a jury after an *indictment* (formal, written accusation) has been prepared. A person accused of a summary offence is tried by magistrates in a court of summary jurisdiction. See *Court Justice of the peace*; *Magistrate*.

Indictable offences. Common law groups indictable offences in three categories: treasons, felonies, and misdemeanours.

Treasons are crimes that endanger the country or the sovereign. Examples of treasons are spying for the country's enemies in time of war and attempting to assassinate the sovereign. Treasons are generally punished by long terms of imprisonment.

Felonies and misdemeanours. In some countries, felonies and misdemeanours are separate categories of crime. Felonies are crimes, such as murder or robbery, that are punishable by death, in countries where the

death penalty is in use, and by *forfeiture* (confiscation) of the criminal's property. Misdemeanours are indictable crimes other than treasons and felonies, and do not carry the death penalty. Examples of misdemeanours are perjury and obtaining money by false pretences.

The classification of crimes as felonies or misdemeanours is inexact. Even within one country, not all courts draw the same distinction between felonies and misdemeanours. The distinction between felonies and misdemeanours was formally abolished in the UK in 1967. In the United States, and the Australian states of New South Wales and South Australia, crimes are still classified as felonies and misdemeanours.

Summary offences are minor offences that are tried by magistrates. Summary offences include acts that cause annoyance to the public, most traffic offences, and minor cases of dishonesty.

Crimes against people or property. Crimes against people include assault, kidnapping, murder, and sexual attacks. Such crimes usually bring severe punishment. Crimes against property include arson, burglary, embezzlement, forgery, fraud, theft, and vandalism. In most cases, these crimes carry lighter penalties than do crimes against people.

Robbery is the crime most difficult to classify. The law generally considers robbery a crime against the person. Robbery involves taking property from a person by using force, such as a mugging.

Crimes against public order or morality include disorderly conduct, illegal gambling, prostitution, public drunkenness, and *vagrancy* (having no permanent residence or visible means of support). These offences generally involve lighter penalties than do crimes against people or property.

Criminologists question whether some offences against public order or morality should be considered crimes. For example, many experts believe that habitual drunkenness is a medical problem and that the offender should be given medical help instead of being put in jail. There is also wide disagreement about whether certain practices hurt society and should be considered crimes. Such acts include gambling and the use of certain drugs such as marijuana.

Organized crime consists of large-scale activities by groups of gangsters or racketeers. Such groups are often called the *crime syndicate* or the *underworld*. Organized crime specializes in providing illegal goods and services. Its activities include gambling, prostitution, the illegal sale of drugs, and *loan-sharking* (lending money at extremely high rates of interest). Many of these activities are often called *victimless crimes* because both the buyer and the seller take part in them willingly.

Most activities of the crime syndicate are not reported to the police. People who use the illegal services try to avoid the police. When the crime syndicate invades a legitimate business or trade union, it uses terror, blackmail, and other methods to keep people from going to the police. Even when the illegal activities are discovered, prosecutors have difficulty convicting the gangsters because of the lack of reliable witnesses. In addition, the syndicate frequently tries to bribe witnesses or law officers and sometimes succeeds in doing so. The syndicate also furnishes bail money and lawyers for members who are arrested.

White-collar crime originally included only criminal acts committed by business and professional people while earning their living. The term referred to such crimes as stock market swindles and other kinds of fraud. Today, the term covers such acts as cheating in the payment of taxes—which may or may not be done in connection with one's business. It may apply to petty thefts by employees, as well as to large-scale stock market swindles. It could also include a garage owner's charging for a car repair that was not made, or a dentist's charging a patient for services that were not performed.

The increasing use of computers has created new opportunities for white-collar crime. Computer crimes are difficult to detect but easy to accomplish once a criminal learns the code or password to activate the system. Thus, automatic bank tellers increase the possibility of fraud or theft from banks. Computer access by bank employees creates additional opportunities for *embezzlement* (stealing money entrusted to their care by their employers).

Many consumer protection laws are aimed at white-collar crime. These laws regulate business and professional activities to protect consumers. During the 1960's and early 1970's, consumer protection became one of the fastest growing fields of criminal law. See *Consumerism*.

Political crime has become an increasingly serious criminal activity. It includes acts of terrorism against innocent people and assassinations of leading political figures throughout the world. Unlike many criminals who seek money or personal gain through crime, most terrorists and assassins commit crimes to show support for a political cause. Since the early 1970's, political crimes such as aeroplane hijackings, assassinations, bombings, and the taking of hostages have become more frequent. As a result, governments all over the world have taken steps to protect against terrorists. For example, security at airports, embassies, and other potential targets has been increased, and specially trained law enforcement or military units have been formed to combat terrorism.

The extent of crime

Crime is one of the world's oldest social problems. Almost every generation has felt itself threatened by increasing crime and violence. However, no country has yet developed completely reliable methods for measuring the volume and trend of crime.

Countries vary greatly in their definition of crime and in the reliability of their crime statistics. Conditions that affect the amount of crime also vary from one country to another. Such conditions include the proportion of people living in cities, the proportion of young and old people in the population, and the degree of conflict among various cultural, economic, and racial groups.

One basis of comparison is the murder rate in various countries. Most murders are reported to the police, though their definition may vary. In 1988, the number of reported homicides per 100,000 population was 4.5 in Australia, 2 in England and Wales, 0.8 in Indonesia, 1 in the Republic of Ireland, 2 in Malaysia, 2 in Singapore, and 8.4 in the United States.

A comparison of the changing crime rates within a

country proves more valuable than comparing the rates of two or more countries. Studies show that crime rates for both violent crimes and property crimes are rising in most countries. For example, from 1975 to 1985, the violent crime rate in the United Kingdom increased 60 per cent and the property crime rate increased 55 per cent. During this same period, the violent crime rate in the United States increased 15 per cent, but the property crime rate decreased 3 per cent.

Comparisons of the crime rates of various nations indicate that increases in crime accompany increases in the rate of social change. The crime rate stays relatively stable in traditional societies where people believe their way of life will continue. Crime rates tend to rise in societies where rapid changes take place in where people live and what they do for a living—and in their hopes for their future well-being. Crime rates are particularly high in industrial nations that have large cities.

Unreported crime. Statistics about crime are based on complaints to the police, offences observed by the police, and arrests of suspects. Much crime goes unreported. One survey of 10,000 families in the United States has shown that family members were victims of major crimes in over twice as many offences as those covered by police statistics that year. Many other types of crimes also remain unreported, including offences against businesses, organizations, and public agencies and against public order and morality.

The cost of crime to its victims is impossible to determine accurately. Any estimate based on existing data will probably underestimate the cost considerably. For example, a dishonest business scheme may cost consumers or investors vast sums of money, but no records are kept of such losses. Similarly, there is no way to determine the profits to the crime syndicate of drug sales, gambling, loan-sharking, and prostitution.

The cost of crime prevention and control measures is also difficult to determine. Law enforcement and criminal justice agencies also deal with many noncriminal matters, such as traffic control. Probably about 40 per cent of police costs can be directly charged to crime control. In addition, most courts handle both criminal and civil cases.

Causes of crime

People commit crimes for various reasons. For example, many people steal things they could not obtain otherwise. Others, such as drug addicts, steal to get money to buy drugs or other things they need. Some shoplifters steal for excitement, but others do so to stretch the family budget. Many car thieves take cars for joy-riding, but others strip down the stolen cars and sell parts. Many embezzlers take money from their employers to meet a personal emergency, intending to return the money.

The motives also vary in crimes of violence. A robber may kill the victim to avoid detection. Some gangsters torture people to obtain money. A man may beat his wife in a fit of rage during a quarrel.

Biological and psychological explanations. Many studies have sought to explain crime. Most of them compare habitual criminals with people who have not been convicted of crimes to try to find important differences between the two groups.

Since the late 1800's, for example, researchers trained in the biological sciences have searched for physical differences. Such studies involve differences in body type, the pattern of brain waves, and the formation of genes. None of these studies has proved that criminals have any physical traits that make them different from other people.

Research by psychiatrists and psychologists stresses personality differences resulting from experiences in childhood or later. This research shows that many people who became criminals were neglected by their parents or were given harsh or uncertain discipline. Such treatment left them insecure and demanding in their relations with others. Their own wants made them ignore the needs or rights of others. But researchers have had difficulty making a direct connection between emotional needs and crime because many people with emotional problems find acceptable ways of solving them.

Social conditions and crime. Sociologists have conducted crime studies that focus on the neighbourhood and community rather than on the individual. Some of these studies deal with how a person becomes committed to a career of crime, and others try to explain differences in crime rates.

The highest crime rates occur in the most deprived sections of large cities. These are the areas where it is most difficult to train children to become law-abiding citizens. Such areas have the highest rate of broken homes. Even in many homes where both parents are present, emotional conflicts and health and financial problems affect family life. Slum areas usually have the poorest schools and the highest unemployment rates. These neighbourhoods have much run-down, overcrowded housing and poor recreation facilities.

For many young city-dwellers, the excitement of the streets provides the principal escape from boredom and seemingly unsolvable problems. These streets are also the scene of much vice and crime—drugs use and sale, gambling, prostitution, public drunkenness, and acts of violence. Law enforcement in the inner city is difficult, partly because too few police officers patrol the neighbourhoods. In addition, many of the people fear the police and refuse to cooperate with them.

Most residents of the high-crime slum areas of many large cities are members of minority ethnic groups. As a result, the crime rate for such minority groups is higher than that for the majority group. The minority groups are also more likely to become the victims of crimes. This tendency need not mean that such minorities are more criminal. It could arise because the lower income and less privileged social groups to which they belong tend to bear the brunt of law enforcement in all countries. Also, it may reflect drinking patterns, or the fact that, because of the life styles for such groups, they are most likely to be on the streets and in contact with police.

In many countries, most crimes are committed by boys and young men. They are particularly likely to commit burglaries, car thefts, and robberies.

However, women are committing more crime, especially more economic crime, than before. This trend is common throughout countries of Western culture. It reflects the greater freedom that women have today as well as their widening opportunities. More women

enter the labour force now, and women are more apt to find themselves in situations in which they are confronted by crime.

The lower age limits of offenders are falling. More children and young people commit serious offences than previously. Again, most Western countries share this phenomenon.

There are several reasons why young people commit most crimes. As people become older and settled in their jobs and the rearing of children, they acquire a stake in society that they would not care to risk for momentary gain. On the other hand, many young people have few job opportunities. The unskilled jobs available seem dull when compared to the quick and exciting returns from theft. Young people are also more willing to risk arrest because they have less stake in things as they are.

Many violent crimes are committed by people who were acquainted with their victims. In a high proportion of murders, for example, the killer and the victim knew each other. In fact, about a sixth of all murders committed in the United States, for example, are committed by a member of the victim's family. In numerous cases, because so many murderers know their victims, the police have a relatively easy time identifying the killer. As a result, the arrest and conviction rate for murders is high. Police have a much harder time identifying robbers and burglars, few of whom know the victims.

Crime prevention

For hundreds of years, the criminal law has been built around the idea that wrongdoers must be punished for their crimes. The most basic argument for punishment is that it preserves law and order and respect for authority. From this point of view, punishment does two things. It upholds the law, and it prevents others from thinking they can get away with doing the same thing without punishment. Punishment is based on the idea that many people have a barely controlled desire to act in forbidden ways. By punishing those who break the law, we reassure ourselves that we are right in controlling this desire. Thus, punishment is believed to maintain broad support for the law.

Many criminologists stress the need for improving the performance of criminal justice agencies—the police, the courts, and the prisons. For example, criminologists point out that better educated, equipped, and coordinated police forces are more effective in controlling crime.

One way to reduce crime is to reform or rehabilitate habitual criminals. The fundamental problem is not the first offender or the petty thief but the repeated offender who commits increasingly serious crimes. According to criminologists, crime would decrease greatly if all such offenders could be turned away from wrongdoing. However, prisons have had little success in rehabilitating inmates. A large proportion of the people arrested in any year has a previous criminal record.

Rehabilitation of criminals could probably be improved greatly if experts could provide the right kind of programme for different types of offenders. Criminals vary widely in the kinds of crimes they commit, their emotional problems, and their social and economic backgrounds. Not all offenders can be helped by the

same course of treatment. Many require medical or psychiatric help. Others respond well to educational or vocational training. However, nearly all the funds for prisoners pay for the food, clothes, and control of prisoners.

Since the late 1970s, there has been a trend toward punishment rather than rehabilitation of offenders in many countries. Prison sentences are longer. Capital punishment has been used more frequently in the United States since the Supreme Court lifted a death penalty ban in 1976. In some Islamic countries, the death penalty and mutilation have been enforced by courts for offences other than murder. Nevertheless, crime prevention should aim to prevent people from becoming criminals in the first place. Such a goal probably would benefit from reform programmes in urban slums. These programmes would cover improved housing, schools, recreation, and increased job opportunities.

There are many other ways to reduce crime. People can be educated or persuaded to take greater precautions against crime. They can be taught, for example, how to protect their homes against burglary. Car thefts would drop sharply if all drivers removed their keys and locked their cars when leaving them. Better lighting helps discourage handbag snatchings and other robberies on city streets and in parks. Many experts believe that stricter gun-licensing laws would reduce crime.

Related articles. See the *World Book* article on *Criminology*. See also the following articles:

Crimes

Arson	Forgery	Perjury
Assassination	Fraud	Polygamy
Assault and battery	Gambling	Rape
Bigamy	Hijacking	Riot
Blackmail	Homicide	Robbery
Breach of the peace	Juvenile delinquency	Sabotage
Bribery	Kidnapping	Slander
Burglary	Libel	Smuggling
Conspiracy	Lynching	Terrorism
Contempt	Manslaughter	Treason
Counterfeiting	Mayhem	Trespass
Embezzlement	Murder	Vagrancy
Euthanasia		Vandalism
Extortion		

Law enforcement procedures

Arrest	Handcuffs	Police laboratory
Bail	Indictment	Search warrant
Court	Inquest	Telephone tapping
Criminology	Legal aid	Voiceprint
Fingerprinting	Lie detector	Warrant
Footprinting	Police	

Punishment

Capital punishment	Carrot	Procurator fiscal
Deportation	Gas chamber	Rack
Ducking stool	Guillotine	Scottish law
Electrocution	Hanging	Sentence
Exile	Parole	Stocks
Fine	Pillory	Torture
Forfeiture	Prison	Whipping post
	Probation	

Other related articles

Amnesty	Feud	Pardon
Bandit	Mafia	Vendetta

Crime laboratory. See *Police laboratory*.

Crime prevention. See *Crime (Crime prevention)*;

juvenile delinquency (Prevention of delinquency); *City (Social problems)*.

Crime syndicate. See *Crime (Organized crime)*.

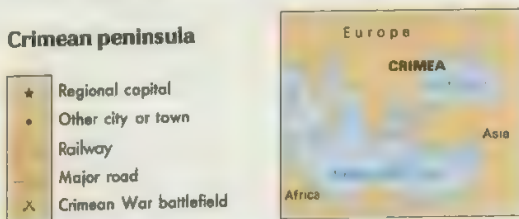
Crimea, a region of Ukraine, is a peninsula that juts from the southern part of Ukraine into the Black Sea and the Sea of Azov. The Crimea covers an area of about 27,000 square kilometres and is joined to the mainland by the narrow Isthmus of Perekop. The population of the Crimea is about 2,309,000. The capital is Simferopol. Other cities include Kerch, Sevastopol, historically important Balaklava, and Yalta, scene of the historic conference of Allied leaders in World War II (1939-1945).

The Crimea rises gradually from coastal plains to the low Crimean Mountains along the southern coast. There are forests of oak, beech, pine, and olive trees. The grassy plains furnish pasture for sheep and horses. Grapes from the vineyards are used to make wine. Grains flourish in the northern lowlands of the peninsula. Important deposits of iron, marble, and limestone have been found in the Crimea, and salt is dried along the coasts. The chief industries are shipbuilding, mining, and fishing. Resorts and health centres line the coasts.

The Crimea was one of the strongholds of opposition to the Communist government after the Russian Revolution of 1917. Russian troops put down the opposition in 1921, and the Crimea became an autonomous republic within the Russian republic of the Soviet Union.

During World War II, German troops occupied the peninsula from 1941 to 1944. In 1944, Soviet authorities forcibly deported about 250,000 Turkic-speaking people called Tatars from Crimea to Siberia and Central Asia. The Crimean Tatars were falsely accused of collaborating with the Germans. In 1967, these charges were dropped, but the Tatars were prevented from returning to the Crimea in large numbers. The Crimea's autonomous status was removed in 1945, and it became a prov-

Crimean peninsula





The Crimean coast has many beautiful resort towns. Yalta, above, lies on the southern coast, near the Crimean Mountains.

ince of Russia. In 1954, the Soviet Union made the Crimea part of the Soviet republic of Ukraine. In 1991, following an upheaval in the Soviet Union, Ukraine declared itself an independent nation. It became part of the Commonwealth of Independent States, a loose association of former Soviet republics. In 1992, Russia declared the 1954 decision to give Crimea to Ukraine unconstitutional. However, Ukraine opposed this declaration.

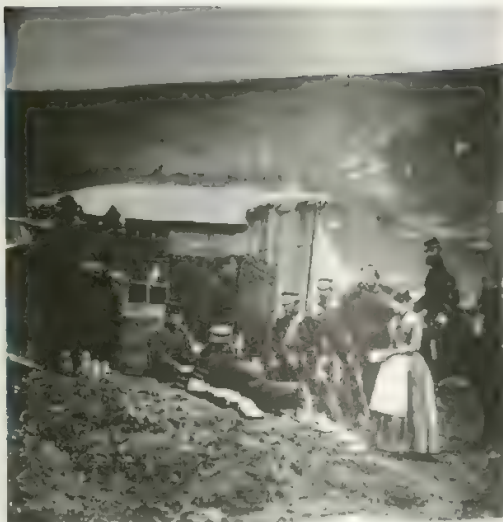
In 1993, Ukraine granted Crimea political and economic autonomy. The majority of people in Crimea are of Russian origin. Some are Russian nationalists who want Crimea to separate from Ukraine and unite with Russia. Ethnic Ukrainians strongly oppose the Russian nationalists. Nationalists gained a majority in elections held in Crimea in 1994.

See also **Crimean War; Sevastopol; Yalta.**

Crimean War (1853-1856) was fought between Russian forces and the allied armies of France, the Ottoman Empire (now Turkey), Sardinia-Piedmont, and the United Kingdom (UK). The war's name comes from the Crimean Peninsula, an area of present-day Ukraine where much of the fighting took place (see **Crimea**). The war started from a dispute over the status of the Christian Orthodox Church in the Islamic Ottoman Empire. But the long-term causes were far more complex. Austria, France, and the United Kingdom had become increasingly concerned over Russian intentions in the Balkans and were determined to frustrate Russia's expansionist policies in that area.

Russia occupied the Danubian principalities (now Romania) in July 1853. The UK immediately dispatched a fleet to Constantinople (now Istanbul) to support the Turks. Turkey declared war on Russia in October 1853, opening an offensive in the Danubian principalities. In January 1854, after the Russian fleet destroyed a Turkish squadron at Sinope, France and the UK sent fleets into the Black Sea to protect Turkish merchant shipping. In March, France and the UK declared war on Russia. To prevent Austria joining the alliance against them, the Russians withdrew from the Danubian principalities in August. Austria then occupied the principalities.

In September 1854, France and the UK landed troops in the Crimea. The troops began a year-long siege of the fortresses surrounding Sevastopol. In January 1855, Italian leader Count di Cavour sent 10,000 well-equipped



The Crimean War was the first major war recorded by news paper photographers and reporters. This photograph shows soldiers at a British camp.

Sardinian troops to the aid of France and the UK. Cavour hoped to gain support in his quest for Italian unification.

The allied troops fought bravely in the battles of Alma (Sept. 20, 1854), Balaklava (Oct. 25, 1854), and Inkerman (Nov. 5, 1854). For the location of these battlefields see **Crimea** (map). On Sept. 11, 1855, the French successfully attacked the Malakhov, a key stronghold in the Russian defences. The Russians were forced to abandon their forts, *scuttle* (sink) their ships, and evacuate Sevastopol. Thereafter, the war dragged on until February 1856. Militarily and economically exhausted, and fearful of renewed Austrian intervention in the Balkans, Russia reluctantly agreed to preliminary peace terms. Full peace was established at the Congress of Paris, where a peace treaty was signed on March 30, 1856. The Treaty of Paris forced Russia to give up some territory it had taken from the Ottoman Empire and forbade warships on, and fortifications around, the Black Sea.

The war was badly commanded and administered on both sides. Generals, many of whom were far too old for field command, clung on to outdated Napoleonic military concepts, often with disastrous results. Sanitation in the camps was virtually nonexistent. Little heed was paid to the needs of private soldiers, who died in thousands from dysentery, cholera, and other preventable diseases. Florence Nightingale led a team of 38 nurses, who sailed from the UK to Scutari to establish a hospital for the wounded. But medical conditions remained primitive and far more men died of their wounds than died outright in action.

The Crimean War was the first major military engagement to be observed at first hand by newspaper reporters and photographers. Sir William Russell of *The Times* telegraphed daily reports to London. He described the suffering of the troops, the total lack of basic supplies, and the inefficiency of senior officers. The English poet Lord Tennyson wrote a famous poem, "The Charge of the Light Brigade," about the Battle of Balaklava.

The Crimean War did little to bring stability to eastern Europe. Alexander II, who became czar of Russia in 1855, at the height of the war, introduced far-reaching economic and military reforms to try and overcome his country's backwardness. Cavour used the Congress of Paris as a platform for demanding Italian unification against the wishes of Austria. Prussia realized that Austria's isolation created a potential void in Central Europe, and began to sow the seeds of German unification.

See also Balaklava, Battle of; Cavour, Count di; Nightingale, Florence.

Criminal law. See Crime; Law.

Criminology is the scientific study of crime, criminals, criminal behaviour, and the criminal justice system. Criminologists conduct research that examines factors related to crime. They also study individuals to learn how and why people become criminals. Most research in criminology involves such related fields as sociology, psychology, and psychiatry.

Criminology helps provide an understanding of the nature of crime. The results of criminological research help guide community leaders and law enforcement officials in their efforts to prevent crime. Criminologists also help determine the best methods of treating offenders.

Criminology is generally taught in the law, medicine, or sociology faculty of a college or university. Some universities have separate departments of criminology or criminal justice. Studies in criminology have traditionally emphasized the relationship of biological characteristics to criminal behaviour. Today, however, criminology places greater emphasis on the social and environmental causes of crime. Therefore, social science research plays an increasingly important role in criminology.

What criminologists study

Criminologists devote much research to personal and other factors that may cause crime. Most criminological research examines environmental conditions associated with crimes. Some studies concentrate on the connection between crime and such biological factors as brain structure and chemical imbalances. Others emphasize the role that people's emotions and motives play in criminal behaviour.

Sociological theories and methods serve as the basis for most studies of environmental causes of crime. Many criminologists investigate the relationship between crime and other social problems, including poverty, poor housing, and overcrowding. Some study the ways in which individuals learn criminal behaviour through association with people—including criminals—who have little regard for the law.

Criminologists also study *penology*, the science of the punishment and treatment of offenders. During the early 1900's, penologists began to stress *rehabilitation*, the treatment of criminals with the goal of restoring them to useful lives. However, studies during the 1970's showed that rehabilitation had little success. Today, criminologists recommend making punishment more certain than ever, bringing people to trial quickly, imposing fair and uniform sentences, and providing prisons that are more humane.

Most criminologists do not consider criminal investi-

gation techniques as a part of criminology. Persons who analyse evidence and do other investigative police work are normally members of police forces. See *Police*; *Police Laboratory*.

Methods of criminology

Criminologists use a wide variety of research techniques. The two most important methods are *statistical studies* and *case studies*.

Statistical studies help criminologists to formulate and to test their theories. These experts use statistics to study both the crime rate and the characteristics of criminals. Crime statistics help criminologists find relationships between crime rates and certain physical or social conditions. For example, such studies may show that the crime rate increases when poverty and unemployment rise. Criminologists generally use statistics compiled by government agencies.

Criminologists also use statistics to learn about personality traits or social conditions that are more common among criminals than other people. Researchers usually compare a group of criminals with a group of noncriminals who are similar to the lawbreakers in most ways. Differences between the two groups can be measured in this manner. Any personality trait or social condition that occurs more frequently among criminals may be one of many causes of criminal behaviour.

Case studies. In a case study, a criminologist examines all the personality traits and social conditions that affect one criminal. The researcher studies the person's family history, environment, physical condition, psychological state, and many other characteristics. All these details help determine how certain conditions produce criminal behaviour in an individual. Some case studies are conducted on certain groups of criminals, such as rapists or juvenile gangs. A criminologist may use the results of a case history to work out a theory about the development of criminal behaviour.



A criminologist interviews a criminal as part of a case study. Interviews help criminologists learn about personality traits and social conditions that may cause criminal behaviour.

History

Criminology began to develop as a distinct area of study during the 1700's. In 1764, an Italian economist named Cesare Bonesana, Marchese di Beccaria, wrote *On Crimes and Punishments*. This book became the foundation of the *classical school* of criminology.

Beccaria and his followers protested at the severe punishments that were common for criminals at that time. They argued that the only purpose of punishment should be to prevent future crime. Beccaria assumed that criminals had free will and that pleasure and pain determined their actions. He believed crime could be prevented by the certainty and speed of punishment, rather than its severity. According to Beccaria, everyone who violated a specific law should receive the same punishment, regardless of age, sex, wealth, or social position. In modified form, the principles of the classical school are the basis of criminal law today in many nations.

The *positive school* of criminology, also known as the *Italian school*, developed during the late 1800's. In general, this school shifted the emphasis of criminology from crime itself to the study of criminals and the possible causes of their actions. The positivists believed criminal behaviour resulted from conditions beyond the control of the criminal.

An Italian doctor named Cesare Lombroso was the most important leader of the positive school. He studied many criminals and concluded that certain physical traits made them different from other people. His ideas have been proved false, but his scientific approach to crime laid the basis for modern criminology.

During the 1900's, criminologists have proposed a wide variety of theories about crime. Edwin H. Sutherland, an American criminologist, developed the *theory of differential association*. It states that all criminal behaviour is learned through association with criminals or people with unfavourable attitudes toward the law. Other criminologists believe the structure of society leads some people to choose criminal methods to achieve such socially approved goals as wealth and status. Still others argue that society produces crime, and so crime can be reduced or eliminated only by changing the organization of society.

See also Crime; Juvenile delinquency; Prison.

Crinoid. See Sea lily.

Cripps, Sir Stafford (1889-1952), was a well-known British statesman and diplomat. As Chancellor of the Exchequer in the Labour Party government from 1947 to 1950, he introduced the necessary but unpleasant policy of austerity. He coined such phrases as "Export or Die," meaning that Britain had to earn money overseas, in order to buy necessities, or starve. His devaluation of the pound in 1949 was extremely unpopular with the nation. Cripps resigned in 1950 because of illness



Sir Stafford Cripps

brought on by overwork. Cripps believed that Christian principles should govern a nation's political life. His books include *Towards a Christian Democracy* (1945).

In 1931, Cripps was appointed solicitor general in the Labour government. But he later resigned because he refused to serve in J. Ramsay MacDonald's emergency coalition government. He was expelled from the Labour Party in 1939 because of his extreme left-wing views. From that time until 1945, he sat as an independent member of Parliament.

Cripps was appointed ambassador to the Soviet Union in 1941 by Winston Churchill, the leader of the wartime coalition government. In February 1942, he was appointed lord privy seal and leader of the House of Commons. Late in 1942, he succeeded Lord Beaverbrook as minister of aircraft production (see Beaverbrook, Lord). Cripps held this post until the end of the war. After the Labour Party's election victory in 1945, Cripps was readmitted to the party.

Cripps was born in London and named Richard Stafford Cripps. He studied chemistry at Oxford University and later did chemical research at University College, London. He also took up law, becoming a barrister in 1913.

Cristallo glass. See Glass (The Middle Ages).

Critical mass. See Nuclear energy (Chain reactions; Nuclear weapon (Fission weapons)).

Critical temperature. See Gas (How gases behave).

Criticism is the analysis and judgment of works of art. It tries to interpret and to evaluate such works and to examine the principles by which they may be understood. Criticism attempts to promote high standards among artists and to encourage the appreciation of art. It also helps society remain aware of the value of both past and present works of art.

Criticism plays an important part in every art form. This article emphasizes literary criticism.

Kinds of literary criticism. Criticism can be divided into four basic types. They differ according to which aspect of art the critic chooses to emphasize. *Formal criticism* examines the forms or structures of works of art. It may also compare a work with others of its *genre* (kind), such as other tragic plays or other sonnets. *Formal criticism* is sometimes *intrinsic*—that is, it may seek to treat each work of art as complete in itself. *Rhetorical criticism* analyses the means by which a work of art affects an audience. It focuses on style and on general principles of psychology. *Expressive criticism* regards works as expressing the ideas or feelings of the artist. It examines the artist's background and conscious or unconscious motives. *Mimetic criticism* views art as an imitation of the world. It analyses the ways that artists show reality, and their thoughts about it.

The four types of criticism can also be combined. For example, a critic who looks at the form of a work might also study the way this form affects an audience.

History of literary criticism. The ancient Greek philosopher Plato was the first known literary critic. He accused poetry of imitating the mere appearance of things. Aristotle, his pupil, defended epic poetry and tragic drama. In his *Poetics*, Aristotle said that poetry is an instructive imitation—not of things but of actions. Other early essays on criticism tended to be rhetorical handbooks that taught writers how to achieve certain ef-

fects. These essays included *Art of Poetry* by the Roman poet Horace and *On the Sublime* by the Greek writer Longinus.

During the late 1500's, such critics as the English poet Sir Philip Sidney praised literature as the image of an ideal or golden world. In the 1600's and 1700's, critics turned their attention to defining the rules by which they thought works should be written and judged. The three most important English critics of this period were John Dryden, Samuel Johnson, and Alexander Pope.

At the end of the 1700's, critics in Germany and England began to regard literature as an expression of the author's imagination. These critics, called romantics, compared the forms of poems to those of living creatures, each with its own organic unity. Johann Wolfgang von Goethe, Friedrich Schiller, and the brothers August and Friedrich Schlegel were important German romantic critics. The greatest of the English romantic critics were Samuel Taylor Coleridge and William Hazlitt.

In the mid-1800's, critics stressed the relation between art and society. The English writer Matthew Arnold thought poetry should be "a criticism of life," which could help people lead finer, more cultured lives.

The American critics of the 1800's insisted that American experience was different from that of Europe and therefore required a different sort of art.

In the early 1900's, the poet T. S. Eliot argued for a criticism that would be the servant of poetry, not of society. I. A. Richards, an English critic, developed methods of close reading. He asked readers to pay attention to the exact meaning of the text, not to impose their own ideas on it. In the mid-1900's, a movement called the *New Criticism* became popular. Associated with such American critics as Cleanth Brooks and John Crowe Ransom, New Criticism analysed a work of literature as a self-contained whole, without reference to its historical period, the author's life, or other external influences.

In the 1950's, many critics turned from interpretative criticism to issues of theory. Many other theories of literature were also debated, including those of Northrop Frye of Canada, Kenneth Burke of the United States, Walter Benjamin of Germany, Roland Barthes of France, and Mikhail Bakhtin of the U.S.S.R. These competing theories led to many new ways of analysing literature.

Related articles in *World Book* include:

Aristotle	Plato
Arnold, Matthew	Poe, Edgar Allan
Boileau-Despréaux, Nicolas	Realism
Classicism	Richards, I. A.
Coleridge, Samuel Taylor	Romanticism
Dryden, John	Ruskin, John
Eliot, T. S.	Sainte-Beuve, Charles A.
Goethe, Johann W. von	Schiller, J. C. Friedrich von
Hazlitt, William	Shakespeare, William (Shakespearean criticism)
Horace	Taine, Hippolyte Adolphe
Howells, William Dean	Tate, Allen
Johnson, Samuel	Wilson, Edmund
Literature	Wordsworth, William
Longinus	
Naturalism	

Cro-Magnons were a type of prehistoric human being who lived in Europe, Asia, and North Africa from about 40,000 to 10,000 years ago. The name Cro-Magnon comes from the Cro-Magnon cave near Les Eyzies, in southwestern France. The first skeletons of Cro-Magnons were found in the cave in 1868, and more than 100 skeletons have since been discovered. The skeletons indicate that these early people were strong and had a height of more than 170 centimetres. Their bone structure was similar to the bone structure of modern people's. Scientists believe that Cro-Magnons were an early form of modern human being.

Cro-Magnons hunted game on the cold, grassy plains of Europe. Ice sheets covered much of Europe when the Cro-Magnons lived there. Cro-Magnon hunters made weapons with tools of bone and stone. They also used such tools to scrape skins and to sew hides for clothing and shelter. The tools varied from place to place, and the people improved them through the centuries. Most Cro-Magnons lived in shelters built in the open, but some made shelters in caves. Some family groups may have wandered long distances. They probably exchanged such items as special rocks for toolmaking with other groups.

Some Cro-Magnons produced beautiful cave paintings. They painted animal pictures in caves in southwestern France and northern Spain. They also made bone carvings and modelled in clay.

Croagh Patrick is an isolated mountain about 760 metres above sea level that rises in County Mayo, in



Croagh Patrick, a mountain in the Republic of Ireland, is visited by thousands of pilgrims on the last Sunday in July. St. Patrick is said to have banished all reptiles from the island of Ireland by ringing a handbell on Croagh Patrick.

the Republic of Ireland. Irish Roman Catholics regard it as a holy mountain because St. Patrick is said to have spent 40 days in prayer and fasting on its summit, praying for the success of his mission in Ireland. Patrick, who became the patron saint of Ireland, was chiefly responsible for converting the Irish people to Christianity.

On the last Sunday of July, thousands of pilgrims climb the mountain to attend Mass in the tiny *oratory* (room used for prayer).

Croaker. See Drum (Fish).

Croatia is a country in southeastern Europe that declared its independence in June 1991. In 1918, Croatia had become part of the Kingdom of the Serbs, Croats, and Slovenes, later renamed Yugoslavia. In 1946, Yugoslavia became a federal state consisting of six republics, one of which was Croatia. War broke out in 1991 after Serbia, another Yugoslav republic, opposed Croatia's declaration of independence. Serbia seized about a third of Croatia's territory within a few months. A ceasefire in January 1992 ended most of the fighting, though some fighting continued. Serbian troops continued to occupy about a third of Croatia.

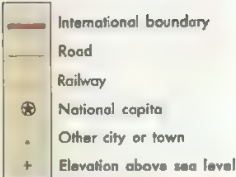
Croatia covers 56,538 square kilometres. It borders on Slovenia and Hungary to the north, Serbia to the east, Bosnia-Herzegovina to the south, and the Adriatic Sea to the west. Zagreb, Croatia's capital and largest city, is the centre of cultural and political life in the country. Other important towns in Croatia are, in order of size, Split, Rijeka, Osijek, and Dubrovnik. Osijek and Dubrovnik were heavily damaged during the war.

From 1945 to 1990, Communists held a monopoly on power in Croatia, as in all of what was then Yugoslavia. In 1990, non-Communists won a majority of seats in Croatia's first multiparty elections.

Government. Croatia adopted its first democratic constitution in December 1990, while it was still a Yugoslav republic. The 1990 Constitution guarantees freedom of speech, assembly, press, and religion. It also promises the right to form political parties and the right of minority groups to cultural independence.

The voters elect the president of Croatia to a five-year term. The president may be reelected only once. A two-

Croatia



house parliament makes the laws. The people elect the members of parliament to four-year terms.

The most important political party in Croatia is the Croatian Democratic Union, an organization that promotes pride in Croatian culture. Other parties include the Social Liberal Party, the Social Democratic Party (formerly the Communist Party), the Croatian Democratic Party, and the Party of Rights.

The Supreme Court is Croatia's highest court. A special committee chosen by parliament appoints members of this court to life terms. Croatia also has a constitutional court. The parliament names the 11 judges of this court to eight-year terms. About 20,000 men and women serve in Croatia's armed forces.

People. Before the war, Croats made up about 75 per cent of the population of Croatia. Serbs made up more than 10 per cent. For Croatia's total population, see the *Facts in brief* table with this article. Most of the Serbs lived in or around Knin, a town in southwestern Croatia. Pockets of other nationalities also lived in Croatia, sometimes in villages of a single ethnic group. But many of these people fled after Serbian forces destroyed their villages.

The Croatian and Serbian languages are so similar that experts consider them two forms of a single lan-

Facts in brief about Croatia

- Capital:** Zagreb.
- Official language:** Croatian.
- Official name:** Republika Hrvatska (Republic of Croatia).
- Area:** 56,538 km². *Greatest distances*—north-south, 465 km; east-west, 465 km.
- Elevations:** *Highest*—Mount Troglav, 1,913 m above sea level. *Lowest*—sea level along the coast.
- Population:** *Estimated 1996 population*—4,801,000; *density*, 86 people per km²; *distribution*, 51 per cent urban, 49 per cent rural. *1991 census*—4,784,265. *Estimated 2001 population*—4,817,000.
- Chief products:** *Agriculture*—apples, cattle, cherries, maize, grapes, olives, pears, pigs, plums, potatoes, poultry, sheep, soybeans, sugar beet, tobacco, wheat. *Manufacturing*—chemicals, petroleum, ships, textiles. *Mining*—bauxite, coal.
- Flag:** The flag has horizontal stripes of red, white, and blue. The coat of arms is in the centre. See *Flag* (picture: *Flags of Europe*).
- National anthem:** "Lijepa naša domovino" ("Our Beautiful Homeland").
- Money:** *Currency unit*—kuna.



Zagreb is Croatia's capital and largest city. People shop for fruit and vegetables at an outdoor Zagreb market, left. The St. Etienne Cathedral rises in the background.

guage, often called Serbo-Croatian. Croatian is written in the Roman alphabet and Serbian usually employs the Cyrillic alphabet, the system of writing also used in Russian. After the war began, Croats began a campaign to further distinguish Croatian from Serbian. They sought to restore ancient Croatian words and to invent new words with Croatian roots. Many Croats, especially those in the major cities or along the Adriatic coast, speak either German or English in addition to Croatian. Most Croats are Roman Catholics. The traditional religion of the Serbs is the Serbian Orthodox faith.

Before the war, almost half the people of Croatia lived in rural areas, and the rest lived in cities. But the war destroyed many villages, forcing people to flee to Zagreb and other cities. Most rural families live in wooden houses with steep roofs. Many suburban residents have homes in modern high-rise apartment buildings. City dwellers often live in older houses or flats.

Croats value close family ties. Traditionally, the father holds the most authority in the family. Since the mid-1970's, however, a women's rights movement has grown in Croatia, especially in Zagreb. The movement has challenged the traditional ideas about authority in the family and called for women to have economic, political, and social equality with men.

Croatian cooking is similar to that of other central European countries. One of Croatia's best-loved dishes is *Zagreb veal cutlet*, breaded veal slices. Another traditional Croatian dish is *gibanica*, a layered cheese pastry that may be eaten alone or with a meat dish. Croatia also makes some excellent wines.

Almost all adults in Croatia can read and write. Children are required to attend school between the ages of 6 and 14. Croatia has universities in Rijeka, Split, and Zagreb, and many other institutions of higher education.

Croatia has a lively cultural tradition. During the early 1900's, Croatian sculptor Ivan Meštrović became famous for his highly patriotic and religious works. Traditional dances of the Croats include the *kolo*, a fast-paced dance performed in a circle. Jazz festivals attract large audiences in Croatia, and classical music is also popular. Rock music, too, is extremely popular and has served as

a means of expressing strong political views. During the 1970's and 1980's, many Croatian rock groups performed songs that criticized the Communist system or its policies. Since the 1980's, many rock groups have promoted Croatian pride and desire for independence.

Land and climate. Croatia consists of two land regions: (1) Dalmatia and (2) the Pannonian Plains. Dalmatia, a coastal region between the Adriatic Sea and Bosnia-Herzegovina, has rocky cliffs and little fertile soil. The fertile Pannonian Plains, which include the historic region of Slavonia, border on Hungary. The Dinaric Alps extend through the centre of Croatia. Croatia's two main rivers, the Drava and the Sava, flow into the Danube, one of the most important waterways in Europe.

Dalmatia has a mild climate. In winter, the temperature rarely falls below freezing. However, a cold, gusty wind called a *bora* sometimes blows down from the mountains into the northern areas in autumn and winter. Summers are sunny, hot, and dry. The Pannonian Plains have cold winters with a freezing wind called a *košava*. Summers are dry and hot. Temperatures often rise to about 38 °C. Heavy rains in spring and autumn frequently cause floods along the Danube River and its tributaries.

Economy. Croatia had a high standard of living when it was part of Yugoslavia. Much of Croatia's wealth came from tourism and money sent home by Croats working in Germany and Austria. But Croatia also expanded its agriculture, cattle-breeding, and shipbuilding industries. In 1990, Croatia abandoned Communism and began to establish a free-enterprise system, in which businesses could operate without government control.

Zagreb is Croatia's leading manufacturing centre. Major industries include chemicals, petroleum, shipbuilding, and textiles. Croatia is also an important producer of cement and steel. The most valuable mineral resources in Croatia are bauxite and coal.

Croatia's chief crops are maize, potatoes, soybeans, sugar beet, tobacco, and wheat. The major fruit grown in Croatia are apples, cherries, grapes, olives, pears, and plums. Farmers also raise cattle, pigs, poultry, and sheep.



Croatia's dramatic coastline along the Adriatic Sea has traditionally drawn many tourists. Holidaymakers swim and sunbathe at a beach on the Makarska Riviera, near Split, above. War in the 1990's caused a sharp decline in tourism.

Tourism has contributed greatly to Croatia's economy. Resorts along the Adriatic coast and on the islands of Brač, Hvar, and Krk are popular tourist sites. The historic walled city of Dubrovnik also draws many sightseers. However, the tourist industry in Croatia suffered from the war.

Croatia's major trading partners are Austria, Germany, and Italy. These countries and the United Kingdom provide most of the tourist traffic to Croatia.

Croatia has a good system of roads and railways. However, the war damaged parts of the transportation network and blocked access to much else. Serbian forces have occupied some roads leading to Bosnia-Herzegovina and have destroyed bridges spanning the Sava River. In addition, some rail lines run through Serb-occupied areas and cannot be used.

Croatia has airports in Pula, Rijeka, Split, and Zagreb. The country's major seaports are Dubrovnik, Rijeka, Šibenik, and Split.

The leading daily newspapers in Croatia are *Večernji list* and *Vjesnik* of Zagreb and *Slobodna Dalmacija* of Split. *Danas*, a weekly magazine, and *Globus*, a weekly newspaper, are also popular.

History. Slavic tribes began to settle in what is now Croatia during the A.D. 600's. In 803, Croatian tribes accepted the rule of Charlemagne, a Germanic ruler who united much of western Europe to form a great empire. Soon afterward, the Croats converted to Christianity. Croatia was an independent kingdom in the 900's and 1000's.

In 1102, Kálmán, the king of Hungary, also became king of Croatia, thus creating a political union between Croatia and Hungary that lasted for more than 800 years. Despite this union, the Croats always kept their own parliament, called the *Sabor*.

In 1526, the Ottoman Empire, based in present-day Turkey, defeated a Hungarian army in the Battle of Mohács. As a result, much of both Hungary and Croatia came under Ottoman rule. The Habsburgs, an Austrian royal family, gained control of the rest of Croatia at about the same time. Most of Croatia remained under

Ottoman rule until it was transferred to the Habsburgs by the Treaty of Karlowitz in 1699. In 1809, Croatia became part of the Illyrian Provinces of Emperor Napoleon I of France. In 1815, the Habsburgs once again took over Croatia. In 1867, the Habsburg Empire was restructured as the *Dual Monarchy* of Austria-Hungary. Austria and Hungary had equal political status within the restructured monarchy. Hungary took over Croatia. The following year, Croatia signed the famous *Nagodba* (agreement) with Hungary. The agreement guaranteed Croatia some of its historic rights.

Austria-Hungary fought on the side of the defeated Central Powers in World War I (1914-1918). After the war, it was broken into a number of pieces. In 1918, Croatia joined Bosnia, Montenegro, Serbia, Slovenia, and other territories to form a new state. It was called the Kingdom of the Serbs, Croats, and Slovenes. The Croats hoped they would have full equality and regional *autonomy* (self-rule) within the kingdom. Instead, the Serbs used their greater military power to enforce centralized rule from Belgrade, the Serbian capital. In addition, taxation, military promotions, and banking policies discriminated against the Croats in favour of the Serbs.

In 1921, the Serbs passed a new Constitution despite objections by the Croats. The Croatian Peasant Party—then the largest political party in Croatia—boycotted sessions of the legislative assembly held to draft the Constitution. The party continued its boycott of the assembly for several years. King Alexander I of Serbia took the throne of the combined kingdom under the Constitution. In 1929, the king changed the name of the kingdom to Yugoslavia and began to rule as dictator. He was assassinated in 1934 by a Bulgarian who had been hired by a Croatian terrorist group. Hostility between the Croats and Serbs continued.

In 1939, an agreement granted Croatia much control over its own affairs and those of Bosnia-Herzegovina. However, the outbreak of World War II later in the year ended this agreement.

In 1941, during the war, the Axis powers—led by Germany and Italy—invaded and occupied Yugoslavia. Croatia was proclaimed an independent state, but it was actually controlled by the Axis. Croatia was forced to turn over much of its coastal territory to Italy but was given control of Bosnia-Herzegovina.

After the war ended with the defeat of the Axis in 1945, Communists came to power in Yugoslavia. Josip Broz Tito, secretary-general of the Communist Party, became the country's prime minister and later became president. Under a constitution passed in 1946, Yugoslavia was organized as a federal state—that is, one in which the powers of government were shared between a central government and republics. Croatia then became one of Yugoslavia's six republics, as did Bosnia-Herzegovina. In 1947, most of Istria, which had belonged to Italy, became part of Croatia. In 1963, a new Constitution was enacted. It gave the republics some control over their own affairs. After the passage of this Constitution, Croats began to press for greater independence.

Between 1967 and 1971, Croatian politics became increasingly liberal. Many Croatian leaders openly resented Serbia's influence in the federal government and demanded more control over Croatian affairs. In 1971,

Tito forced many Croatian liberals to leave their posts, including Savka Dabčević-Kučar and Miko Tripalo, Croatia's leading political figures. From 1971 to the death of Tito in 1980, Croatia was ruled by conservatives who kept liberal economic reforms, but enforced a stricter line in political and cultural spheres.

After Tito's death, the federation that made up Yugoslavia began to unravel. Many Croats called for complete independence. They complained that the federal government took too much of Croatia's income and that Serbia sought to control Croatia and the other republics.

Croatia's relations with Serbia worsened dramatically in the late 1980's with the rise to power of Serbian leader Slobodan Milošević. Milošević, a strong supporter of Serbian unity and the expansion of Serbia's borders, began to rally the Serbian minority in Croatia against the Croatian government. Croatia and another Yugoslav republic, Slovenia, sought political reforms that would transform Yugoslavia into a union of independent states. Serbia and Montenegro, on the other hand, aimed to make Yugoslavia into a centralized state. After negotiations failed, Croatia and Slovenia each declared independence in June 1991.

In 1990, Milošević had begun smuggling large quantities of arms and other military equipment to Serbs living in Croatia. When war broke out between Croatia and Serbia in June 1991, these Serbs fought alongside the Yugoslav National Army against the Croats. Croatia lost more than 30 per cent of its territory to the Serbs within a few months. The war also destroyed about 40 per cent of Croatian industry, as well as many historic buildings and monuments. About 10,000 people were killed in the fighting.

In early 1992, the United Nations sent a peacekeeping force of about 14,000 to Croatia. But scattered fighting has continued to break out in Croatia, especially in the northeast. In April 1992, Serbia and Montenegro joined to form a new state of Yugoslavia, thus seeming to accept Croatia's independence.

See also **Meštrović, Ivan**; **Split**; **Stepinac, Aloysius Cardinal**; **Yugoslavia (History)**; **Zagreb**.

Croatoan. See **Lost Colony**.

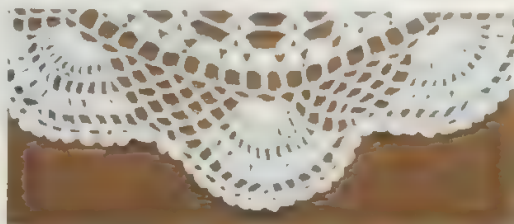
Croce, Benedetto (1866-1952), was probably the most distinguished Italian philosopher of the 1900's. He believed there are two kinds of knowledge: that which comes from understanding and that obtained from the imagination. For Croce, imagination rules art.

Croce helped revive interest in the work of the Italian thinker Giambattista Vico and influenced the reassessment of the ideas of the German philosopher G. W. F. Hegel. Croce had a major impact on British philosophy of art and history through his influence on the writings of the English philosopher and historian R. G. Collingwood. Croce founded and edited *La Critica*, a journal of literature, philosophy, and history. His major books include *Aesthetic* (1902), *Philosophy of the Practical* (1908), *Logic* (1909), and *History as the Story of Liberty* (1938).

Croce was born in Pescasseroli, near Pescara. He was appointed a senator in 1910. Croce helped reform Italian schools in the 1920's. He was an opponent of the Fascist government of Benito Mussolini and was a leader in liberal intellectual circles in Italy.

Crocheting is a way of making lace by methods similar to knitting. Crochet lace is heavy and inexpensive. Al-

most any yarn or thread may be crocheted, but the most common is a hard-twist cotton thread. The lace is made by looping a single yarn or thread into fabric or a chain by means of a needle called a *crochet hook*. It is a narrow piece of metal, bone, wood, or plastic about 15 centimetres long that ends in a barlike hook. The French word *crochet* means *crook* or *crooked*.



Crochet lace is made with yarn or thread and a crochet hook. Crocheting produces a great variety of patterns. The illustrations below show how to make two stitches.

Chain stitch



Make a loop or slipknot in thread and place it on hook.



Arrange thread from ball around fingers of left hand.



Hold the work with the left thumb and forefinger.



Catch thread and pull it back through loop for first stitch.



Continue chain stitches. Practice makes even stitches.

Single crochet



Crochet 21 stitches. Insert hook in second loop back.



Catch the thread and draw it back through the chain.



Catch the thread again and draw it back through both.



Continue to make a single crochet in each chain stitch.



At end of row, make a chain, turn work, and start new row.

A person can create many more variations of pattern with crochet stitches than with knitting needles. One can combine the three main stitches: chain, single crochet, and double crochet. The *chain* stitch is used to cast on and create pattern spaces. *Single crochet* creates solid-pattern shapes and bars in an openwork pattern. *Double crochet* is used in the same way as single crochet, but is twice as wide. Other crochet stitches include *netting*, the *rose stitch*, and the *shell stitch*.

Crocheting is done with fine thread and a fine hook for lacy doilies and trimmings. A medium thread and needle are used for crocheting bedspreads, gloves, and potholders. With wool yarn and a needle of medium size, a person can crochet shawls, berets, sweaters, and blankets. Heavy yarns or fabric strips may be crocheted using a large crochet hook to make carpets or mats.

The Irish are famous for their beautiful crochet work. Crochet lace was introduced into Ireland about 1820. Using very fine thread, Irish women developed a type of lace using a series of three-leafed shamrocks, roses, and little rings surrounded by a lacy background of chain stitches with small *picots*, or knots. This lace can be recognized by the whiteness of the linen thread used.

Crockett, David (1786-1836), was one of the most famous frontiersmen in United States history. He became a first-rate hunter and Indian fighter who used his reputation to build a political career. Crockett became a symbol of the American frontier. Crockett died fighting in the war that won Texas independence from Mexico.

Early life. David Crockett was born in Greene County, Tennessee. The Crockett family moved to Jefferson

County, also in Tennessee, in 1796. Davy started school at about the age of 13, but ran away from home for about 2½ years to avoid being punished for truancy. In 1806, Crockett married Mary (Polly) Finley. They had three children. In 1813, Crockett became a U.S. Army scout. He fought in the Creek Indian War in what is now part of Alabama and Florida until 1815. His wife died that year. In 1816, Crockett married Elizabeth Patton. They moved to western Tennessee in 1817.

Political career. Crockett held several positions, including justice of the peace, town commissioner, and colonel of the county militia. He served in the Tennessee legislature from 1821 to 1824, and in the U.S. House of Representatives from Tennessee from 1827 to 1835.

In Congress, Crockett opposed President Andrew Jackson on land reform and a bill to relocate Indian tribes. But Crockett lost his reelection bid for Congress in 1835, and his presidential ambitions ended.

The Alamo. In November 1835, Crockett set out for Texas at a time when Texas was fighting to gain its independence from Mexico. In early February 1836, he joined about 187 men who had established a fort at the Alamo, an old Roman Catholic mission in San Antonio. When Mexican troops attacked the fort, the men held them off for nearly two weeks until March 6. Some historians believe that a few men, perhaps including Crockett, survived the battle but were then executed by the Mexicans. See **Alamo**.

The legends. Crockett told many tall tales about himself. He may also have exaggerated his claim to have killed 105 bears in seven months. Crockett has been the subject of songs, books, TV programmes, and films.

Crocodile is one of the largest living reptiles. Crocodiles, alligators, gavials, and caymans look much alike, and are all called *crocodilians*. Both crocodiles and alligators have a long, low, cigar-shaped body, short legs, and long powerful tails with which they swim. They both have tough hides, long snouts, and sharp teeth to grasp their prey. In most crocodiles, however, the snout comes to a point in front, whereas an alligator's snout is rounded.

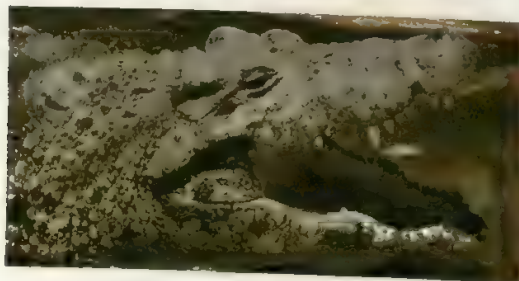
Crocodiles live in tropical countries throughout the world. They prefer large bodies of shallow water, sluggish rivers, open swamps, and marshes. Their webbed feet allow them to walk on the soft ground. Their eyes and nostrils are higher than the rest of the head. This arrangement fits in with the crocodile's life in the water, for it likes to float with only its eyes and nostrils above the surface. Its throat has a slitlike valve in front of the tube leading to its nostrils. This valve shuts tight when the animal is under water. It keeps the water from entering through the mouth when the reptile seizes its prey.

Crocodiles eat many small animals, such as fishes, birds, and turtles, which they seize and swallow whole. Occasionally they attack large animals and people. A crocodile can twist a large animal into pieces by seizing it and then rapidly spinning lengthwise in the water. Crocodiles are more aggressive than American or Chinese alligators and should be left alone.

Like most reptiles, crocodiles lay eggs. These look like hens' eggs, but are longer and have a less brittle shell. Crocodiles conceal their eggs in nests of rubbish and vegetation, or they bury them in sand beaches. The female of some types guards the nest until the young



A crocodile's body is long and low. The animal uses its short legs, *above*, mainly for walking on land. Its sharp teeth are set in strong jaws, *below*, that can snap a heavy board in two.





The mugger crocodile lives in southern Asia. The colour of its body provides camouflage by blending in with the mud and water of its surroundings.

are hatched. When she can hear the young reptiles grunting, she digs them out of the nest. Some crocodiles help their young hatch and then carry them in their mouth to the water. Not much is known about the breeding habits and general behaviour of crocodiles.

Most of the true crocodiles inhabit the Eastern Hemisphere. The *Nile crocodile* is found widely in Africa. This animal lives almost everywhere on the continent except in the Sahara and on the northern coast. This reptile was known by ancient peoples and described by the Greek historian, Herodotus. The small, long-snouted crocodile of the Congo Basin grows no longer than 2.5 metres. The two kinds of dwarf crocodilians of Africa, one of which is very rare, are closely related to true crocodiles.

The giant *saltwater crocodile* lives in many places from India to northern Australia, and even in the Solomon Islands. The *mugger* lives in India, Pakistan, and Sri Lanka; and the *Siamese crocodile* inhabits Java, Thailand, and nearby parts of Asia. There is also an *Australian crocodile*. Sumatra and the Malay Peninsula have the *false gavia*. The false gavia has a narrower snout than most other crocodilians. It uses its long snout to catch fish.

Four species live in North and South America. The *American crocodile* lives in the extreme south of Florida, on the larger West Indian islands, and in Central America and areas near it.

The crocodilians are remnants of a large and ancient group of reptiles. Fossils show that these reptiles once reached a length of 15 metres. This is more than twice as long as any crocodiles living today. There are now 12 species of crocodiles.

Crocodiles have been widely hunted for their hides, which manufacturers make into leather for shoes and handbags. Such hunting has caused three species—the American crocodile, Cuban crocodile, and Nile crocodile—to become endangered species. Laws now forbid crocodile hunting in many parts of the world, but these restrictions are difficult to enforce. Biologists in some areas have begun programmes to collect crocodile eggs and hatch them in incubators. The baby crocodiles are then released into the wild.

Scientific classification. Crocodiles belong to the family Crocodylidae.

See also Alligator; Gavia; Reptile.

Crocodile bird. See Courser.

Crocus is a flowering herblike plant that grows in southern Europe and Asia, and is cultivated in many regions of the world. It grows from a thick, bulblike stem called a *corm*. The leaves look like large leaves of grass. Crocus flowers grow at ground level. Each blossom is

made up of six segments, and has three stamens and a pistil. Some crocuses bloom early in spring, and others bloom in the autumn.

Gardeners plant crocuses about 8 centimetres deep in rich, well-drained soil. New corms form on top of old ones, so gardeners replant crocuses every few years. Probably the most popular crocuses are the purple and *cloth-of-gold*, a bright orange-yellow.

Crocus is the Latin word for *saffron*. Saffron was once used extensively to make a yellow dye and as a spice for food. Commercial saffron is obtained from the dried stigma of crocus plants cultivated chiefly in France, Italy, and Spain. The town of Saffron Walden in Essex, England, is named after the once extensive cultivation of saffron crocuses in the area. The dye has largely been replaced by aniline dyes.

Scientific classification. Spring crocuses belong to the iris family, Iridaceae. They make up the genus *Crocus*. The cloth-of-gold crocus is *Crocus susianus*. The saffron crocus is *Crocus sativus*. Autumn crocuses belong to the lily family, Liliaceae. They are genus *Colchicum*.

See also Aniline; Colchicum; Flower (picture: Garden perennials (Bulbs)); Saffron.

Croesus (reigned 560-546 B.C.) was the last king of Lydia, a country in what is now western Turkey. Croesus raised Lydia to the peak of its power, conquering Greek coastal cities and extending his empire to the Halys River (now called the Kizil River) in central Asia Minor. During Croesus' reign, Lydia achieved vast wealth through gold mining and extensive trade.

Croesus succeeded his father, Alyattes, as king. In 549 B.C., he formed an alliance with Babylonia, Egypt, and Sparta against Persia. He attacked the Persians in about 545 B.C., expecting help from his allies. But help could not reach him, and he withdrew to Sardis, his capital. Cyrus, the Persian leader, followed him there, defeated him, and made Lydia part of the Persian Empire.

Croft, William (1678-1728), was an English organist and composer. He composed highly regarded church music, much of which is still in use. He also wrote many hymn tunes. One of these, "St. Anne," is the tune most often used for "O God, Our Help in Ages Past." Croft was born in Warwickshire.



Crocuses

Crofter is the tenant or owner-occupier of a croft in northern Scotland. A *croft* is a piece of farmland, rarely more than 30 hectares in extent and rented at not more than £100 a year. The crofting areas are located in Highland Region, Shetland, Orkney, Western Isles, and a small part of Strathclyde Region.

Most crofters are farmers. But for many crofters, fishing, public works, the tourist trade, or crafts such as weaving may be more important. The Crofters Commission administers crofts.

Crofters' war was a series of agrarian disturbances in Scotland in the years 1882 to 1888. Many of the people of Highland Scotland had in earlier years been systematically evicted from the central glens by landlords who wished to introduce sheep into the area. The evicted tenants had been resettled on strips of land known as crofts. Many of these crofts were on islands, and some of them still exist. The landlords later took more farmland for deer stalking and grouse shooting and evicted other tenants for rent arrears. These actions caused the crofters to resist.

In 1882, the crofters' resistance erupted into the so-called "Battle of the Braes" at Glendale, Skye. Marines and gunboats supported the local police against the crofters. An Act of 1886 improved the crofters' conditions and brought the disturbances to an end.

Crohn's disease. See Ileitis.

Cromarty. See Ross and Cromarty.

Crome, John (1768-1821), was one of the great English landscape painters. The Norfolk countryside inspired many of his landscapes, as did the countryside of Belgium and France, which he visited in 1814.

Crome was born in Norwich, Norfolk, where he worked as an errand boy. Later, he was an assistant to a house painter, and then became a teacher of drawing. In 1803, he was one of the founders of the Norwich Society of Artists. Later, Crome exhibited his work at the Royal Academy, in London.

Crompton, Richmal (1890-1969), a British author, created the comic character of William, a boy whose vivid imagination and thirst for adventure are always

getting him into trouble with the adult world. She wrote more than 30 books about the adventures of William and his friends, the "Outlaws." These books include *Just William* (1922), *William—the Rebel* (1933), *William and the Moon Rocket* (1954), and *William and the Space Animal* (1956).

Richmal Crompton was born at Bury, in Greater Manchester, England, and named Richmal Crompton Lamburn. She was educated at Darley Dale, in Derbyshire, and at London University.

Crompton, Samuel (1753-1827), a British inventor, developed an improved spinning machine that brought about a new era for the British textile industry. In 1779, after years of work, Crompton completed his invention, which combined the principles of two machines, the spinning jenny and the water frame. He designed a spindle carriage that reduced thread breakage by delaying the pull on the threads until they were spun. Crompton's new machine was called *the mule*, because it was a cross between two machines, just as a mule is a cross between two animals. Crompton failed to patent the mule, and received only 67 pounds for the specifications. In 1812, he received 5,000 pounds from the government as compensation, but later lost it in business ventures.

Crompton was born near Bolton, in Greater Manchester, England. As a boy, he used the spinning jenny. But he disliked it because the threads broke so often, and he resolved to design a better spinning machine.

See **Industrial Revolution**.

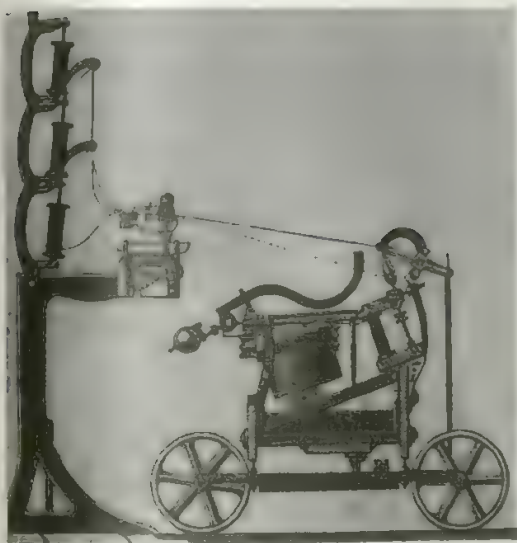
Cromwell, Oliver (1599-1658), led the armed forces of Parliament to victory in the English Civil War during the



William, the hero of books by Richmal Crompton, gets involved in many adventures.



John Crome became famous for paintings of English country scenes. His painting *Mousehold Heath, near Norwich*, left, expresses the beauty and tranquility of the Norfolk countryside.



Samuel Crompton's first spinning mule was hand operated, but later versions were operated by water power.

1640's, and ruled England from 1653 to 1658. He had an iron will and proved to be a military genius. Few leaders have inspired more love and respect or more fear and hatred.

Cromwell was born at Huntingdon, in Huntingdonshire (now Cambridgeshire), England. He came from a wealthy and influential family. Cromwell studied at Sidney Sussex College in Cambridge, but his father's death forced him to leave before getting a degree. In 1628, he was elected to Parliament.

During the 1630's, Cromwell became a dedicated Puritan. Puritans were Protestants who strongly believed in the right of people to follow more simple forms of worship and church organization than those of the Church of England (see **Puritans**).

Rise to power. In 1629, King Charles I dismissed Parliament. He believed that kings got their right to rule from God, not from the people. Charles showed little respect for Parliament and did not recall it until 1640, when he needed it to provide money. The struggle for power between the king and Parliament resumed, and civil war broke out in 1642. Cromwell had won election to Parliament in 1640, and he became its leading general. He had no military experience, but he turned out to be a brilliant cavalry leader. His forces, called the "Ironsides," never lost a major battle. In 1645, Cromwell won the decisive Battle of Naseby. The king surrendered in 1646.

Parliament's supporters split into two rival groups, the Presbyterians and the Independents. The Presby-

terians, who had the most seats in Parliament, wanted Parliament and the king to share political power. Some of the Independents, whose supporters included the chief officers of the army of Parliament, favoured formation of a republic that would be governed entirely by Parliament.

Fighting between the king's sympathizers and the Independents broke out in 1648. Cromwell supported the Independents and put down the revolt. Soon afterward, Parliament's army seized Charles and removed the Presbyterian members of Parliament. Cromwell was a leader in the king's trial and execution in 1649. England then became a republic called the Commonwealth of England. In the next two years, Cromwell crushed uprisings by Scottish and Irish forces and defeated an army loyal to Charles Stuart, son of the executed king.

The Protectorate. Parliament's failure to adopt major reforms upset Cromwell. In 1653, he dismissed Parliament and ended the Commonwealth. Cromwell's military officers then prepared a document that made England a Protectorate. Cromwell became its chief executive with the title of *lord protector*.

Cromwell limited freedom of the press, demanded rigid moral standards, and adopted other strict measures. He also strengthened England's navy and brought Scotland and Ireland under English control. In addition, Cromwell aided the development of English colonies in Asia and North America. In 1657, Parliament offered Cromwell the title of king, but he refused it.

After Cromwell died in 1658, his son, Richard, became lord protector. But Richard was an ineffective ruler and resigned in 1659. In 1660, Parliament invited Charles Stuart to rule as King Charles II.

See also **Charles I; II of England; England (The civil war); Long Parliament; Restoration; Rump Parliament. Cromwell, Richard** (1626-1712), ruled England as lord protector from September 1658 to May 1659. He succeeded his father, Oliver Cromwell, as lord protector. But he could not govern effectively, and a group of political and army leaders forced him to resign. In 1660, Parliament invited Charles Stuart to return from the Continent and rule as Charles II. Cromwell fled to France. He returned to England about 1680 and lived under another name in Cheshunt, Hertfordshire, until his death.

Cromwell was born in Huntingdon, England. He fought with Parliament's forces against King Charles I during the English Civil War in the 1640's. Cromwell was admitted to the Council of State and was named chancellor of Oxford University in 1657.

Cromwell, Thomas (1485?-1540), Earl of Essex, was chief minister to Henry VIII of England. He entered the service of Cardinal Wolsey in 1520 and soon became his chief legal and financial adviser (see **Wolsey, Thomas Cardinal**). Cromwell entered Parliament in 1523. He opposed the treason charges brought against Wolsey. After Wolsey's death in 1530, Cromwell entered



Crayon drawing by Samuel Cooper
Oliver Cromwell



National Portrait Gallery, London

Thomas Cromwell

the service of Henry VIII. From 1533 to 1540, he was Henry's most powerful and capable minister. Cromwell helped Henry to secure his divorce from Catherine of Aragon. He also drafted the acts of Parliament that separated the English Church from the control of the Pope, and that made Henry supreme head of the Church in England. Cromwell used his influence in Parliament to secure Parliamentary consent to these acts.

Cromwell played an important part in the *Protestant reform of the Church in England* (see *Reformation*). Most of his religious reforms had a political motive. In 1535, Henry appointed him Vicar General of the Church in England. Cromwell promised to make Henry the richest king in Christendom. Between 1536 and 1539, Cromwell closed all the monasteries and shrines in England and Wales, and all their property passed to the Crown. Cromwell did several things to make English people Protestant. He ordered English translations of the Lord's Prayer, the Creed, and the Ten Commandments to be read in church. He also ordered a translation of the Bible to be kept in every church for anyone to read. Cromwell was hated by many people because of his power and ruthlessness.

In the spring of 1540, Cromwell was created Earl of Essex. But his power had waned. He had arranged Henry's marriage to Anne of Cleves, a German princess. Henry disliked Anne, and turned against Cromwell. In the summer of 1540, the Duke of Norfolk, with the support of the Privy Council, accused him of treason. Cromwell was sent to the Tower of London and beheaded on Tower Hill.

Cromwell's probable birthplace was Putney, now in London. As a young man he led a life of adventure. He fought in the Italian wars and later became a merchant in Antwerp. He returned to London and became a trader and moneylender.

See also *Henry (VIII)*.

Cronin, A. J. (1896-1981), was a popular British novelist. He gained literary fame with his first novel, *Hatter's Castle* (1931), a story of country life in Scotland. Cronin developed a pattern of centring his novels on a single problem or profession, treating it with an engaging combination of realistic detail and romantic plotting. *The Stars Look Down*

(1935) describes poor working conditions in an English mining community. *The Citadel* (1937) is the story of a young Scottish doctor and also a critical study of the medical profession. *The Keys of the Kingdom* (1941) is a moving story about a Roman Catholic missionary priest in China. Cronin's later novels include *A Thing of Beauty* (1956), *A Pocketful of Rye* (1969), and *The Lady with Carnations* (1976).

Archibald Joseph Cronin was born in Cardross, Scotland. He practised medicine from 1919 to 1930. Cronin moved to the United States in the mid-1940's. His autobiography, *Adventures in Two Worlds* (1951), deals with his early years as a doctor.



A. J. Cronin

Cronkite, Walter (1916-), an American television news reporter, was anchorman of the evening news for CBS, a major U.S. broadcasting company, from 1962 to 1981. He won fame as one of the most trusted TV newscasters.

Walter Leland Cronkite was born in St. Joseph, Missouri. He attended the University of Texas at Austin from 1933 to 1935 and worked as a reporter for the Scripps-Howard Newspapers while there. Cronkite joined the United Press (now United Press International) in 1937 and was a correspondent in Europe during World War II.

After the war, Cronkite remained in Europe as a reporter. He served as bureau manager of the United Press in Moscow from 1946 to 1948. Cronkite joined CBS in 1950 and worked as a Washington correspondent for four years. He was transferred to New York City as a correspondent in 1954 and became managing editor of the CBS evening news in 1963. He retired from the evening news in 1981, but remained with CBS, working on special assignments.

Cronus was the youngest child of Gaea, the earth; and Uranus, the sky, in Greek mythology. Unlike most gods, he did not represent a place, event, function, or quality. Cronus belonged to the race of gods known as Titans. The Roman god Saturn closely resembled him.

Uranus feared that his children would overthrow him, and so he confined them within Gaea's huge body. With Gaea's help, Cronus deposed Uranus and became king of the Titans. Cronus married his sister Rhea, and they had six children. Cronus feared that his children would depose him, too, and so he swallowed the first five of them at birth. Rhea hid the last child, Zeus, on the island of Crete. Then she tricked Cronus by giving him a large stone wrapped in baby clothes.

After Zeus grew to manhood, he helped his brothers and sisters escape Cronus. Together, they deposed their father, and Zeus then became the king of the gods.

See also *Mythology* (Greek mythology); *Titans*.

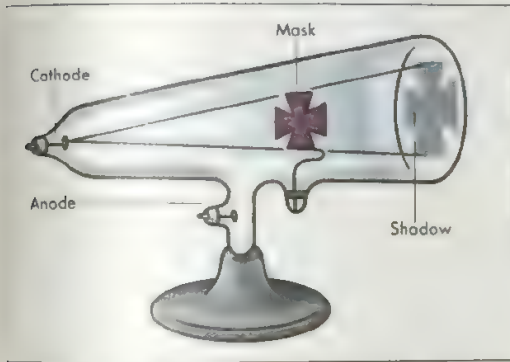
Crookes, Sir William (1832-1919), was a British chemist and physicist. Crookes discovered the chemical element thallium and determined its atomic weight. He also developed several devices that were widely used in scientific research for many years.

During the 1870's, Crookes constructed a vacuum tube for studying a form of radiation called *cathode rays*. This device, later known as the *Crookes tube*, contributed to the development of the modern *cathode-ray tube* that is used in electronic equipment (see *Crookes tube*; *Vacuum tube*). Crookes also invented the *radiometer*, a device that measures the intensity of radiant energy. In addition, he developed an instrument called the *spinthariscopes* for observing high-energy particles emitted by certain radioactive substances.

Crookes was born in London, and graduated from the Royal College of Chemistry in 1851. In 1859, he founded the journal *Chemical News*. He was knighted in 1897.



Walter Cronkite



A **Crookes tube** produces cathode rays. These rays cause glass at the opposite end of the tube to *fluoresce* (give off light). A metal mask blocks some of the rays and casts a shadow.

Crookes tube is a type of vacuum tube. Sir William Crookes, an English physicist and chemist, developed the tube in the 1870's as part of his study of what came to be called cathode rays. His work led to the discovery that these rays consist of streams of electrons.

A Crookes tube has electrodes at or near each end, and low air pressure inside. When a strong electric current flows from the *cathode* (negative electrode) to the *anode* (positive electrode), a glow appears in the end of the tube opposite the cathode. Crookes concluded that invisible rays from the cathode caused the glow. To study the rays, Crookes placed small objects in the rays' path within the tube.

In 1879, Crookes suggested that the rays consisted of streams of negatively charged molecules. The English physicist Sir Joseph J. Thomson confirmed that the rays were charged particles of matter in 1897. Crookes tubes were forerunners of television picture tubes. Today, the Crookes tube is used only for classroom demonstrations.

See also **Cathode rays**.

Crop is a large number of plants of any given kind that are grown for human use. Crops grown to feed people are called *food crops*. Crops that are consumed by animals are *feed crops*. Other crops, called *fibre crops*, produce fibre for use in clothing and other products. Certain other crops are grown to *ornament* (decorate) people's surroundings.

Food crops include fruits, vegetables, and grains such as barley, maize, oats, rice, and wheat. Animal feed crops include *forage*, such as grasses and certain herbs. Cotton, flax, and hemp provide fibre. Ornamental crops include flowers, lawn grasses, shrubs, and decorative trees.

See also **Agriculture** (Chief agricultural products).

Crop, in zoology. See **Animal** (Digestive organs); **Bird** (The digestive system); **Insect** (Digestive system).

Crop rotation. See **Cropping system**.

Cropping system is a method of growing crops and producing high yields without weakening the soil. It involves the combination of different production techniques to provide for the best possible use of the land. In determining the crops and production methods best suited for their land, farmers must consider the composition of their soil; the slope, drainage, and *erosion*

(wearing away) problems of their land; and the land's past cropping history. Production techniques such as different cultivation methods, rotation of crops, and the proper use of fertilizers and pesticides are used in different combinations to aid the farmer.

One of the oldest and most widely used ways of preserving the soil is through the *rotation of crops* (alternating the crops grown in a field from one year to the next). A single crop will use up vital minerals and organic matter in the soil if it is grown in the same field year after year. But different kinds of crops planted in the field on a regular schedule will replace lost minerals and organic matter and help break up plant disease and insect cycles. For example, maize takes nitrogen out of the soil, while crops such as alfalfa and clover put nitrogen into the soil. If maize is planted in a field one year, alfalfa or clover may be planted in it the next year to replace the nitrogen used by the maize crop. The nitrogen-producing crop can also be ploughed into the soil. When it rots, it replaces lost organic matter and enriches the soil. On sloping land, grasses and deep-rooted crops are often alternated with other crops to hold the soil in place and prevent erosion.

The use of fertilizers is gradually replacing the crop rotation system as a means of producing the most profitable crops year after year while still keeping soil fertile. Nitrogen fertilizers and other fertilizers have been developed that can restore lost minerals to soil. When these fertilizers are added, and the proper cultivation and pest control methods are used, the same crop can be planted year after year without harming the soil.

Other developments include chemical pesticides that kill harmful insects, weeds, and microorganisms.

Croquet is a popular outdoor lawn game in which the players use mallets to hit balls through narrow arches called *hoops*. Croquet seems to have originated in Ireland, and the first formal rules were published in England in the mid-1800's. Today, croquet remains largely an informal garden sport in many countries. There are many different versions of the game. However, croquet is played on an organized basis in Australia, South Africa, New Zealand, the United Kingdom, and the United States. This article describes the game as it is played in international competition.

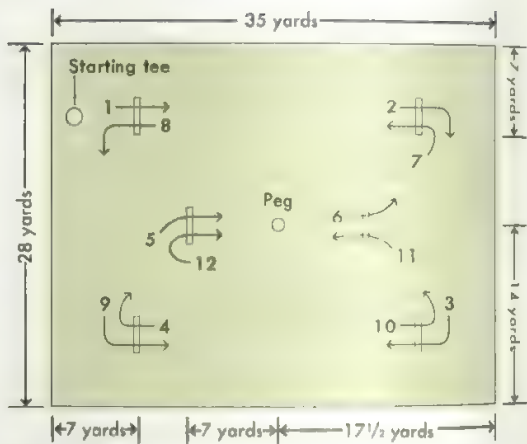
The court and equipment. A standard croquet court measures 35 yards (32 metres) long and 28 yards (26 metres) wide. Players use wooden mallets and two plastic balls. A croquet mallet weighs from 2 to 4 pounds (1 to 2 kilograms). It has a handle 2 to 3½ feet (60 to 105 centimetres) long and a head 10 inches (25 centimetres) long. The game is played with four balls—blue, red, black, and yellow. A croquet ball has a diameter of 3⅝ inches (9.2 centimetres) and weighs about 1 pound (0.5 kilogram).

A wooden peg stands in the centre of the court. It has a diameter of 1½ inches (3.8 centimetres). Six iron or aluminium hoops are at designated places on the court. They are 12 inches (30 centimetres) high and must be no more than 4 inches (10 centimetres) wide.

The game. Each of the two competing sides in a game of croquet has either one or two players. Each player scores points by hitting his or her ball along a required course through the hoops and back again. A player uses two balls in a singles game. A point is



A croquet player scores a point by hitting the ball through a hoop with a mallet. The diagram shows the required course of the balls through the six hoops.



scored each time a ball passes through a hoop or hits the peg at the end of the course. The first side to complete the course, scoring 26 points, wins the game.

Each ball must be played in turn. A player strikes his or her ball once at the start of each turn, and gains extra strokes in one of two ways. (1) If the ball goes through a hoop, the player gains one additional stroke. (2) If the ball hits another ball, the player is entitled to two extra strokes: the first is the *croquet stroke* and the second is the *continuation stroke*. To make the croquet stroke, the player places his or her ball against the other ball, striking it with the mallet so that the other ball moves. The player then takes the continuation stroke.

In the course of a turn, a player may hit and thus *take croquet* from each of the other balls on the court. Once the player's ball has passed through another hoop, the player may repeat the process. In this way, the player can build up a series of points.

Crosby, Bing (1903-1977), was a popular American singer and film star. He became especially well known for his relaxed "crooning" style of singing. Crosby made about 60 films, most of which were musicals and romantic comedies. He introduced his most famous song, "White Christmas," in the film *Holiday Inn* (1942). Crosby won an Academy Award in 1944 for his performance as a singing priest in *Going My Way*. He also co-starred with Bob Hope and Dorothy Lamour in *Road to Singapore* (1940) and six later "Road" comedies.

Crosby was born in Tacoma, Washington. His real name was Harry Lillis Crosby. He started his career in 1924 singing with a Los Angeles band. From about 1927 to 1930, he sang with a trio called the Rhythm Boys. Film and radio appearances and gramophone records made Crosby internationally famous.



Bing Crosby

Crosland, Anthony (1918-1977), a British Labour Party politician, was secretary of state for foreign and commonwealth affairs from 1976 to 1977. He had been secretary of state for the environment since 1974. Crosland was appointed to the Treasury in 1964. He became secretary of state for education and science in 1965, and president of the Board of Trade in 1967. From 1969 to 1970, he was secretary of state responsible for local government and regional planning.

Charles Anthony Raven Crosland was born in London. He was educated at Oxford University. He was a fellow of Trinity College, Oxford, and taught economics. He first became a member of Parliament in 1950.

Cross is the most common symbol of Christianity. It represents the cross on which Jesus Christ was crucified. Christians believe that Jesus' Crucifixion played a central role in redeeming humanity from its sins, and they regard the cross as a sign of redemption. Various groups of Christians have adopted different styles of crosses. Roman Catholics and Protestants chiefly use the Latin cross. This cross is a vertical post with a shorter horizontal crosspiece above the centre. Many Eastern Orthodox churches use the Greek cross, which has four arms of equal length.

During the first 300 years after Christ's death, Christians feared persecution by the hostile Roman government and rarely displayed the cross in public. In the 300's, the Romans began to tolerate Christianity, and crosses were widely displayed in public places. During the early Middle Ages, Christian artists made crosses as symbols of the Christian belief in the Resurrection of Christ. Many of these crosses portrayed the risen Christ wearing priestly clothes and a crown. Later, Christians began to emphasize the sufferings of Jesus in *crucifixes*. A crucifix is a cross with an image of the dying Jesus.

Crosses have a number of uses in Christian worship. A cross on a staff is carried in many processions. During some ceremonies, members of the clergy or worshippers trace the shape of a cross with a hand or certain fingers. Crosses stand above altars in many churches. Cathedrals and many churches have floor plans based on the shape of the Latin cross.

Cross-country is a type of long-distance racing. Unlike track and field races, cross-country competition is not held on a track. Runners usually race across fields or golf courses and often through woods and over hills.

Cross-country running originated in the United Kingdom. The first recorded race took place in 1833 at Rugby School, Warwickshire, England. By the late 1800's, the sport had become popular throughout the U.K. In 1973, the International Amateur Athletic Federation (IAAF) took control of the sport. It adopted rules governing cross-country championships and events. Standard distances for international competitions were fixed at not less than 12,000 metres for men, and 4,000 metres for women. The IAAF world cross-country championships are held annually and are hosted by a different country each year. No national or world records exist because of the differing terrains of the courses.

Cross-examination. See Affidavit; Debate.

Cross-eye. See Strabismus.

Cross-pollination. See Pollen.



Cross-country athletes run uphill in a competition. Courses are designed to include steep inclines and differing terrain

Cross-reference is a method used in books, indexes, library catalogues, and filing systems to direct attention to additional information about a subject in another part of the book or index. Cross-references are widely used in encyclopedias, dictionaries, and textbooks. For instance, this article on Cross-reference mentions indexes. At the end of the article there is a cross-reference reading "See also Index." The reader can find more information about indexes in that article. This type of cross-reference is sometimes called a *related subject* or a *related article*.

Cross-references may also appear within the text of an article or chapter. *The World Book Encyclopedia* article on the famous American author whose pen name was Mark Twain illustrates another kind of cross-reference. Because the author is best known as Mark Twain, his biography is given under Twain, Mark. But because his real name was Samuel Langhorne Clemens, there is an entry Clemens, Samuel Langhorne, which refers the reader to the article on Mark Twain in inverted form: Twain, Mark. This is a direct reference, and will be "See Twain, Mark," not "See also." Some publications use the symbols *cf.* (from the Latin *confer*, meaning *compare*), or *q.v.* (from the Latin *quod vide*, meaning *which see*).

See also Index.

Crossbill is a bird of the finch family. The ends of its bill cross each other. There are four species of crossbill.

The *red crossbill* is found in Europe and Asia, and from Canada to Central America. The male is brick red in colour, with brown wings and tail. It is about 15 centimetres long. The female is a mottled greenish-yellow colour. Crossbills build their nests in coniferous trees, and the female lays three or four pale green eggs with purple to lilac spots. Crossbills nest in any month, whenever there are good crops of conifer seeds. They will even nest in winter, when temperatures can be as low as -20°C . Crossbills feed chiefly on the seeds of cone-bearing trees, using the crossed bill to lift the seed scales from the cones. The birds also eat buds and some insects. Every few years, when food is scarce, crossbills move out of their regular breeding areas. For example, those from northern Asia may migrate as far as south-west Europe, a distance of 4,000 kilometres.



The **cross** is the most familiar symbol of Christianity. The illustration above shows eight styles of crosses that became famous in the history of the religion. The picture below shows a *crucifix*, which is a cross with an image of the crucified Jesus Christ.

Detail of a gilt bronze and lapis lazuli crucifix (1700s); The Art Institute of Chicago





The crossbill uses the crossed ends of its bill to get seeds from fir cones. The male red crossbill, above, is brick red.

The white-winged crossbill is similar in habits to the red crossbill. It breeds in northern Europe and eastern Siberia, Japan, and North America.

Scientific classification. The crossbills belong to the finch family, *Tringillidae*. The red crossbill is *Loxia curvirostra*. The white-winged crossbill is *L. leucoptera*.

See also Finch.

Crossbow was a popular weapon in the Middle Ages. It has a short, stiff bow set across the end of a stock. The archer draws the bow's string back and hooks it on a nut (catch). A short *quarrel* (arrow) is placed against the string. The archer shoots by pulling a trigger that releases the nut. The crossbow was so stiff that the archer put one foot in a stirrup at one end and pulled the string taut with a hook or cord. The crossbow could be cocked and held ready for use, but was slower and had a much



Detail of an illuminated manuscript by an unknown artist; Bibliothèque Nationale, Paris

Turkish forces fought with crossbows in 1480. Some archers used cranks to prepare their crossbows for shooting.

shorter range than the longbow. See also Archery. **Crossman, Richard** (1907-1974), a British politician, was secretary of state for social services in the Labour Party government from 1968 to 1970. He had been minister of housing and local government from 1964 to 1966 and lord president of the Privy Council and leader of the House of Commons from 1966 to 1968.

Richard Howard Stafford Crossman was born in London. He was educated at Winchester College and Oxford University. He was a fellow of New College, Oxford and a writer on political philosophy.

During World War II, Crossman worked in psychological warfare. He became a member of Parliament in 1945. He was chairman of the Labour Party in 1960 and 1961. After he died, publication of his diaries caused great controversy. The diaries were published in three volumes between 1975 and 1977.

Crossword puzzle is a popular word game. It is commonly played on a diagram of black and white squares. A set of numbered definitions or clues is usually printed near the diagram. The object is to answer the clues with words interlocking across and down the diagram. The player writes in each answer word in the row of empty squares starting at the number corresponding to the number of the clue.

Arthur Wynne created the first modern crossword puzzle, which appeared in the Sunday *New York World* newspaper on Dec. 21, 1913. The puzzle became a fad in the United States and spread to other countries. Today crosswords appear in many languages throughout the world. Puzzle championships are held in many different countries.

Crotalaria is any one of a large group of plants of the pea family that grow in tropical countries. Crotalaras are small herbs or shrubs that have yellow flowers. The plants bear compound leaves that generally have three leaflets, as do clover leaves.

A kind of crotalaria called *sun hemp* is grown for its fibres. The fibre is used to make canvas, rope, fishing nets, and cigarette papers. It is stronger and longer lasting than jute.

Scientific classification. Crotalaria is a member of the pea family, *Leguminosae* (Fabaceae). Sunn hemp is *Crotalaria juncea*.

Croton is a group of evergreen, tropical shrubs belonging to the spurge family. There are about 15 species. Crotons are native to Southeast Asia and the Pacific. The plants are grown for their colourful foliage. The leaves are 10 to 15 centimetres long, lance-shaped, or divided into lobes. They may be spotted, streaked, or banded with yellow, white, green, pink, and red. The leaf pattern may vary considerably from one leaf to another on the same plant.

Crotons are grown as indoor pot plants in temperate regions but are planted outside in tropical and subtropical areas.

The plants require a humid atmosphere and plenty of light to bring out the leaf colours. When grown indoors they should be kept away from draughts and sudden changes of temperature.

Scientific classification. The common croton belongs to the spurge family, *Euphorbiaceae*. It is *Codiaeum variegatum*, variety *pictum*.

Croup is an inflammation of the air passages of the throat and windpipe. During an attack of croup, the mu-

cous membranes in these areas become inflamed and swollen, restricting the flow of air. A victim of croup feels hoarse, breathes with extreme difficulty, and wheezes when inhaling. The patient also develops a hollow, barking cough. Croup occurs most frequently among children who are 6 months to 3 years old. Their air passages are small and easily blocked.

Most croup results from influenza, a cold, or some other respiratory infection caused by a virus. Attacks of viral croup last three or four days. In mild cases, doctors prescribe bed rest and breathing moist air from a vaporizer. In severe cases, the patient may receive oxygen and a mist of a drug called *adrenaline*. If the air passages become completely blocked, emergency treatment is necessary to pass a breathing tube into the lungs.

Croup may also be caused by allergic reactions or bacterial infections. Drugs used to treat asthma help relieve croup that results from an allergy. A kind of bacterial croup called *acute epiglottitis* can develop into a life-threatening blockage of the air passages within hours.

See also *Diphtheria*.

Crow is the name of a group of large black birds. Crows belong to the crow family, which includes jays, ravens, magpies, rooks, jackdaws, and fish crows. Crows live in all parts of the world except Antarctica, New Zealand, and South America. There are about 100 species of crows, including the *house crow* of South Asia, the *jungle crow* of East and Southeast Asia, and the *black crow* of South Africa. The *carriion crow* and *hooded crow* of Asia and Europe are closely related. The *common crow* of North America is a different species, but it has similar habits. Other North American crows include the *fish crow* and *Sinaloa crow*. Australia has the *Australian crow* and the *little crow*. North American and Australian crows can best be identified by their different calls rather than by their appearance.

The carriion and American crows are about 50 centimetres long. They have glossy black plumage and strong, sharp-pointed bills. Bristly feathers cover the base of the bill. Their feet are strong and well adapted

for walking. Male and female look almost the same, but the female is slightly smaller. Crows do not have musical voices, but they can make a variety of caws and croaks. They can be taught to speak a few words. Crows are usually seen singly or in pairs.

Crows build their bulky nests in trees, usually high up, or on cliffs by the sea. The female lays four to six eggs. The eggs are pale bluish-green, with irregular blotches and spots of brown and grey.

Crows eat a variety of food, including wheat, insects, shellfish, the eggs and young of other birds, *carriion* (the flesh of dead animals), and *offal* (the waste parts of a carcass). The diet varies with the time of year and the kinds of food available. Farmers do not like crows, because they eat sprouting grain. But crows help farmers by eating insect pests.

Scientific classification. Crows belong to the crow family, *Corvidae*. The house crow is *Corvus splendens*. The jungle crow is *C. macrorhynchos*. The black crow is *C. capensis*. The carriion



The carriion crow, above, lives throughout Europe, North Africa, and Asia. It gets its name because it feeds on *carriion* (dead animals), such as rabbits. House crows, left, are found in India and Sri Lanka. The pied crow, below, lives in many parts of Africa.



crow is *C. corone corone*. The hooded crow is *C. corone cornix*. The common crow is *C. brachyrhynchos*. The fish crow is *C. osifragus*. The Sinaloa crow is *C. sinaloae*. The Australian crow is *C. orru*. The little crow is *C. bennetti*.

See also Jackdaw; Jay; Magpie; Raven; Rook.

Crowe, Martin (1962-), was made captain of the New Zealand cricket team in 1989. He became his country's most consistent batsman in the 1980's. He was also known as a medium pace bowler. Crowe's test career began against Australia in 1982, when he was 19. He scored 188 against the West Indies at Georgetown, Guyana, in 1985. He reached the same score against Australia at Brisbane in 1985.

Martin David Crowe was born in Henderson, Auckland. His older brother Jeff Crowe was also a New Zealand test cricket captain. Martin Crowe first played for Auckland in 1979. Two years later he started playing in England when he spent a year on the Marylebone Cricket Club (MCC) staff. In 1982, he played for Bradford in the Yorkshire League. He played for Somerset between 1984 and 1988. In 1984, Crowe and Peter Roebuck achieved a record third-wicket partnership for Somerset of 319 runs. In 1988, he started playing for Central Districts, in New Zealand.

Crowfoot. See Buttercup.

Crown. See Teeth (Dental decay; picture: Crowning a tooth).

Crown. See Tree (The parts of a tree).

Crown is a British coin worth 25 new pence, or one-quarter of a pound sterling. Once widely used, crowns

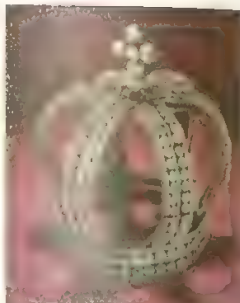


A British crown minted in 1847 displays a portrait of Queen Victoria. The other side shows a coat of arms.

are now coined only for special occasions, such as a royal wedding. They are rarely seen in circulation. On one side, the crown bears a likeness of the king or queen who was reigning when the coin was minted. A coat of arms or other symbolic design is imprinted on the other. The crown was first issued in gold in the 1500's during the reign of Henry VIII. The crown, as it is known today, dates from 1551. Early crowns were made of fine silver, called crown silver. Since 1951, crowns have been struck in copper-nickel alloy.

Crown is a circular ornament worn on or around the head as a symbol of authority, merit, or distinction. A royal crown is a king's or queen's symbol of supreme authority, but is generally worn only on state occasions. Such crowns are usually made of gold, engraved, and ornamented with precious gems.

The British royal crown consists of a gold band studded with diamonds, pearls, and other precious stones.



Historic crowns include the Crown of the Andes, left, from Peru, and the Imperial Russian Nuptial Crown, right.



Historic British crowns include St. Edward's Crown, left, the monarch's coronation crown, copied from a crown worn by Edward the Confessor; and the British Imperial State Crown.

From the band rise crosses, fleurs-de-lis, and four arches, topped by a jewelled gold cross. The crown of the British ruler is thought to be priceless (see Gem [picture]; Elizabeth II [picture]). A few crowns made for princes in India have famous, valuable jewels.

The Crown is a term often used for a monarch in his or her official capacity. It also means a monarch's rule, position, or empire, of which the crown is a symbol.

The history of crowns. Various jewelled head-dresses were worn by rulers of ancient Egypt and Assyria. The Greeks gave a crown or diadem of olive leaves to their athletes as a symbol of victory. Later the Romans adopted this custom. Their crowns were made of metal, usually gold, and were worn by the Roman emperors. From the reign of Constantine (306-337), the diadem was regarded as the symbol of royal power. Later European rulers probably borrowed the practice of wearing a crown from the Romans.

Iron Crown of Lombardy was worn by the Lombard kings and the emperors of the Holy Roman Empire when they became kings of Lombardy. It is made of gold, decorated with jewels and cloisonne enamel. Its name comes from an inner iron circlet which tradition says was beaten from a nail of the cross of Christ. Arti-

sans probably made it in the A.D. 500's. Charlemagne, Emperor Charles V of the Holy Roman Empire, and Napoleon I wore the Iron Crown. It is in the Cathedral of St. John the Baptist at Monza, Italy.

Crown, The, is a term used to describe the power and property of the monarch as head of state. The term refers only to the office that the monarch holds and not to the monarch as a person. For example, in the United Kingdom and in some Commonwealth countries, lands belonging to the state are called *Crown lands*, and are managed by a commissioner appointed by the government. The rents from Crown lands go into the nation's treasury. But the monarch also has personal property, just as every other person has personal property. The monarch's personal property does not belong to the Crown, and the monarch may dispose of it or add to it as he or she wishes. The Crown acts on the advice of officials and through officials. But the monarch has no personal knowledge of many of the acts which are done in the name of the Crown.

When a monarch dies or abdicates, people speak of a *demise of the Crown* (a passing on of the Crown). Monarchs succeed one another from reign to reign. But the Crown is a permanent institution. Diplomats, government ministers, judges, armed forces officers, and other officials appointed by the monarch are not affected by the accession of a new monarch, because they remain servants of the Crown.

The powers of the Crown

The powers of the Crown and of Parliament are often similar, and these powers are sometimes connected and used together. Today, in the United Kingdom, Parliament and government ministers have many powers that once belonged to the Crown. But the Crown still has some powers, called the *royal prerogative*. The Crown can take any action necessary to carry out the nation's laws and to defend the country.

The Crown can declare war, make treaties, and appoint diplomats. But the Crown must have Parliament's consent to pay diplomats and to raise money to fight wars.

The Crown appoints officials to many posts. For example, the Crown appoints judges of the Supreme Court (the High Court and the Court of Appeal) and of the crown court, officers of the armed forces, and bishops of the Church of England. The Crown also makes some Church of England appointments that are junior to bishop. Acting through the Lord Chancellor, the Crown also appoints justices of the peace (see *Lord Chancellor*).

The Crown confers many honours, such as peerages and orders of knighthood (see *Decorations, medals, and orders; Peer of the realm*).

The Crown decides whether to prosecute people, and it has the power to pardon people who have broken the nation's laws, or to reduce their punishments or prevent their being punished. Until the mid-1900's, the Crown could refuse to accept legal actions brought against it. But, except in rare cases, it can no longer refuse to accept such suits. In 1947, Parliament passed a law abolishing the general use of this ancient privilege.

In law, all Britain's government departments are a part of the Crown. But, today, only some crown services still

carry the traditional title *Royal*. These services include the Royal Air Force, the Royal Mint, the Royal Navy, and some corps and regiments of the British Army. But not all bodies that use the title *Royal* are part of the Crown. At various times, monarchs have issued royal charters to independent societies and organizations to give them certain rights.

Since the mid-1800's, Parliament has increased the powers of the Crown by passing laws that enable the reigning monarch to act in some matters through the Privy Council. The instructions of the Privy Council are known as *Orders in Council*.

History

No distinction was made between the monarch as head of state and the monarch as a person until after the Middle Ages. People did not distinguish between the money and property of the state and that of the monarch. In theory, all the land belonged to the monarch. When a monarch died, people occupying all state posts, including appointments in the courts of law, left those posts. Each new monarch appointed people of his or her own choice.

In the early 1700's, Parliament distinguished between money which was granted to the monarch for personal use and money granted for government use. In the early 1800's, an effective professional civil service began to develop.

Related articles in World Book include:

Civil service	Parliament
Monarchy	Privy Council
Order in Council	

Crown colony. See Commonwealth of Nations (Dependencies).

Crown jewels are precious ornaments owned by the kings and queens of England. They consist mostly of crowns, sceptres, and other objects used at coronations (see *Coronation*).

The jewels are kept in the Jewel House at the Tower of London. They are on permanent exhibition to the public, but are carefully protected from fire and theft. Many people ask how much the crown jewels are worth. The gold and jewels alone are worth hundreds of thousands of pounds, and the jewels are in settings of superb craftsmanship. The pieces have great historical importance and are irreplaceable. For these reasons, the value of the crown jewels is incalculable.

One notorious attempt was made to steal the crown jewels, in 1671. Colonel Thomas Blood, an Irish adventurer who had taken the Parliamentary side during the Commonwealth period, managed to steal the crown and orb, but he was caught before he could get to his horse. King Charles II eventually pardoned him.

Crowns. The golden crown made for the coronation of Charles II is the oldest crown in the Jewel House. It is called St. Edward's Crown because it replaced the one supposed to have been worn by Edward the Confessor. This crown is used only for the coronation ceremony. It is the heaviest crown in the Jewel House, weighing nearly 2,300 grams. For this reason, it is worn for only part of the service. Then it is changed for a lighter Crown of State, often called the Imperial Crown.

The Crown of State is worn for such state occasions as the opening of Parliament. It contains more than 3,000



precious stones, including the egg-shaped spinel known as the Black Prince's Ruby, the diamond known as the Second Star of Africa, the Stuart Sapphire, and the square sapphire believed to have come from Edward the Confessor's ring. This square sapphire is the oldest jewel set in the crown. See **Diamond** (Famous diamonds) and **Gem** (Some famous gems).

Swords and spurs. A sword of state is a symbol of the sovereign's authority. Swords, with spurs, are also tokens of knighthood, and the newly anointed sovereign receives them with a reminder of the monarch's duty to do justice by the people, protect the Church, defend the helpless, "and reform what is amiss."

The great Sword of State is a two-handed sword, made in the 1600's, with a hilt designed in the shape of the lion and unicorn supporting the royal coat of arms. During the coronation ceremony, this sword is laid aside and replaced by a lighter jewelled sword, which is buckled about the sovereign. This lighter sword was made during the early 1800's, probably for George IV.

A group of three swords is carried only at the coronation. Two of them stand for justice to the *laity* (people) and to the Church, and the third is Curtana, the Sword of Mercy. The point of Curtana has been broken to symbolize the sovereign's mercy.

The spurs are of plain gold and were made for the coronation of Charles II. They are put on the sovereign's heels during the service and then replaced on the altar. They are designed in a pre-Norman style with simple points.

Orbs and sceptres. The two sceptres and the orb now used in coronations were also made for the coronation of Charles II. The Sceptre With the Cross denotes the sovereign's authority as the ruler of the people. The Sceptre With the Dove (emblem of the Holy Spirit) stands for law and justice, of which the sovereign is the head. The huge diamond in the head of the Sceptre With the Cross is one of the Stars of Africa. It is probably the largest and finest diamond in the world.

The orb is a ball of gold surmounted by a jewelled cross, symbolizing that the Christian faith dominates the world. It is put into the sovereign's hand at one point in the ceremony.

Ampulla and spoon are the oldest articles among the crown jewels. Strictly speaking, they are not royal ornaments but religious vessels used for anointing the sovereign. The ampulla, a golden flask in the form of an eagle, has been used for more than 500 years to hold the holy oil used for consecration. The spoon is even older, dating from the 1100's.

Maces, like swords, symbolize the sovereign's authority. They are ornaments based on a medieval war-club. One of the royal maces is laid upon the table of the House of Commons (the lower chamber of the British Parliament) whenever the speaker is in the chair and the House in session. There are 13 royal maces, 10 of them kept in the Tower.

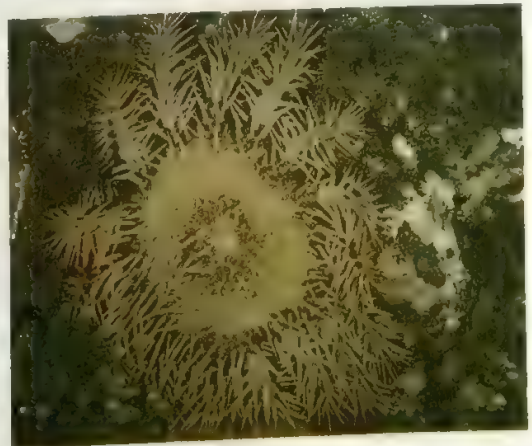
Other royal ornaments. There are many other ornaments, including crowns made especially for various individual sovereigns, and a great deal of beautiful silver plate. The Commonwealth countries presented the *armills* (bracelets) to Queen Elizabeth II for her coronation in 1953. The coronation ring is decorated with a sapphire inlaid with rubies forming the Cross of St. George. During the coronation, it is put on the third finger of the sovereign's right hand.

The Honours of Scotland include a crown, sceptre, and sword of state. They are kept in Edinburgh Castle and may be carried before the sovereign on state journeys through that city. The honours were presented to Queen Elizabeth II on her state visit to Edinburgh following the coronation in 1953. During the troubled times of Cromwell, the Scottish crown jewels were hidden from the English soldiers beneath the pulpit of a church at Kinneff, near Stonehaven, in Grampian Region.

History. When Charles I was beheaded in 1649, Parliament ordered that the ancient crowns and sceptres should be destroyed. Some of these crowns and sceptres probably dated from the reign of Edward the Confessor (1042-1066). At the Restoration in 1660, a new set of crown jewels was made for Charles II. The new set of crown jewels cost just over 21,978 pounds—a sum that shows the great decrease in the value of the pound since that time.

See also **Crown**.

Crown of thorns is a multiarmed starfish that eats the flesh of coral. During the 1960's, swarms of these starfish attacked many of the coral reefs in the Pacific Ocean. By 1970, about 5,200 square kilometres of the Great Barrier Reef was infested with starfish, and on many reefs more than 90 per cent of the hard corals had been killed. Many zoologists were alarmed at the amount of destruc-



Crown of thorns starfish invaded coral reefs in the western Pacific in the 1960's, eating the flesh of the coral. By 1970, the starfish had infested much of Australia's Great Barrier Reef.

The crown jewels, left, include (1) the jewelled Sword of State and Scabbard, (2) St. George's Spurs, (3) Commonwealth bracelets, (4) the Imperial State Crown, (5) the Sceptre With the Cross, (6) the ampulla and anointing spoon, (7) the coronation ring, (8) the Sovereign's Orb, and (9) St. Edward's Crown.

tion to the reef and called for research into methods to control the starfish. But a committee of enquiry set up by the federal and Queensland governments in Australia reported in 1976 that the increase in starfish numbers was due to natural causes. It considered that the reef was in no danger.

Scientific classification. The crown of thorns is a member of the phylum Echinodermata, class Asteroidea. It is *Acanthaster planci*.

Croydon (pop. 299,600) is a London borough on the borders of Surrey. It is one of the fastest-growing development areas in Greater London and the largest London borough in terms of population. The town was severely damaged by bombing during World War II (1939-1945). In 1956, a big programme of redevelopment was begun. The plan provided for office accommodation and expanded shopping facilities. Many firms moved from central London to Croydon.

Croydon also has a civic centre, a technical college, and law courts. The Fairfield Halls include a 1,920-seat concert hall, the Ashcroft Theatre (named after the actress Dame Peggy Ashcroft, who was born in Croydon), and exhibition and banqueting halls. Historic buildings include the Whitgift Hospital, built in 1599, and the old palace of the archbishops of Canterbury, built in the 1300's.

For many years, Croydon was a small Surrey town. It developed rapidly after the opening of the steam railway from London in 1839. Croydon Airport was for many years London's main airport.

Crucifixion. See **Jesus Christ** (The Crucifixion); **Andrew, Saint**.

Crude oil. See **Petroleum** (introduction).

Cruikshank, George (1792-1878), a British artist, became famous for his caricatures and illustrations. His more than 5,000 works range from caricatures to historical paintings. As an illustrator, Cruikshank worked closely with Charles Dickens to produce a famous series of etchings for *Oliver Twist*. He also illustrated books by such writers as Oliver Goldsmith, Henry Fielding, and Miguel de Cervantes. He joined a movement to suppress alcoholism, and produced a series of drawings on the evils of drunkenness. He was born in London, the son of a political caricaturist. See **English literature** (picture: *Oliver Twist*).

Cruiser is a large warship used to escort aircraft carriers and for independent operations with destroyers. Modern cruisers, called *guided missile cruisers*, can fire missiles against aircraft and surface ships, and torpedoes against submarines. Cruisers use radar, sonar, and electronic intercept equipment to detect enemy aircraft, surface ships, and submarines.

Some cruisers have nuclear reactors that provide steam power, and others are powered by gas turbine engines. Cruisers can travel at a speed of about 30 knots.

During World War II (1939-1945), cruisers fought enemy ships and bombarded beaches in support of amphibious landings.

See also **Frigate**.

Crumb, George (1929-), is an American composer known for his innovative and highly individual works. Crumb received the Pulitzer Prize for music in 1968 for his orchestral work *Echoes of Time and the*

River (1967). This work incorporates elements of theatre. Instrumentalists are asked to march and to whisper and shout various short phrases and magical incantations. In the third *movement* (section), a xylophone taps out Crumb's name in Morse code.

Among Crumb's important works are a group of vocal compositions based on poems by the Spanish poet Federico Garcia Lorca. They include four books of *Madrigals* (1965-1969), *Songs, Drones, and Refrains of Death* (1969), and *Ancient Voices of Children* (1970). The latter piece reflects Crumb's fascination with unusual instruments. The work is written for soprano, boy soprano, and an ensemble including percussion instruments, musical saw, and amplified harp and piano. The trio *Vox Balanae (Voice of the Whale)*, 1971 consists of an electronically amplified cello, flute, and piano played by musicians wearing masks. This composition was inspired by Crumb hearing recorded songs of the hump-backed whale. Crumb was born in Charleston, West Virginia.

Crusades were Christian military expeditions organized mainly to recapture Palestine during the Middle Ages. Palestine, also called the Holy Land, was important to Christians because it was the region where Jesus Christ had lived. Palestine lay along the eastern coast of the Mediterranean Sea, and Muslims had taken control of it from Christians. The crusaders, who came from western Europe, organized eight major expeditions between A.D. 1096 and 1270. This was a period when western Europe was expanding its economy and increasing its military forces. The Crusades were a part of a broad Christian expansion movement.

Kings, nobles, and thousands of knights, peasants, and townspeople took part in the Crusades. They had two stated goals: (1) to gain permanent control of the Holy Land and (2) to protect the Byzantine Empire, a Greek Christian empire centred in southeastern Europe, from the Muslims (see **Byzantine Empire**). But many crusaders also fought to increase their power, territory, and riches. The crusaders won some battles and for a time were able to establish a crusader kingdom along the eastern shore of the Mediterranean Sea, but their victories had no permanent effect. However, the Crusades increased already existing contacts between the West and the East. These contacts led to additional trade and commerce.

The Crusades were originally called armed pilgrimages. The word *crusade* comes from the Latin word *crux*, meaning *cross*. Members of the many expeditions sewed the symbol of the cross of Christ on their clothing. "To take up the cross" meant to become a crusader.

How the Crusades began. During the A.D. 500's, the Byzantine Empire controlled much of the land bordering the Mediterranean Sea. This area included southeastern Europe, Asia Minor (now Turkey), Palestine, Syria, Italy, and parts of Spain and North Africa. In the 600's, Arab Muslims conquered Palestine, which included Jerusalem and other places sacred to Christians. Most of the new Arab rulers allowed the Christians to visit the shrines. See **Jerusalem**.

During the 1000's, however, fierce Seljuk Turks from central Asia invaded the Near East and conquered Asia Minor, Palestine, and Syria (see **Seljuks**). The Turks crushed the Byzantines in the Battle of Manzikert in Asia

Minor in 1071. The Turks had become Muslims. But unlike the Arab Muslims, they made it difficult for Christian pilgrims to reach the holy places.

In 1095, Byzantine Emperor Alexius Comnenus asked Urban II, pope of the Roman Catholic Church, for assistance in fighting the Turks. Urban agreed to help. He wanted to defend Christianity against the Muslims and to recover the holy places. He also wished to gain power and prestige for himself at the expense of a rival claiming to be pope. Urban believed that a military expedition against the Turks would unite the Christian knights and nobles of western Europe and end their continual fighting with one another.

In the autumn of 1095, Urban held a meeting of church leaders in Clermont, France. At this Council of Clermont, Urban called for a crusade. He gave a stirring sermon, urging European Christians to stop fighting among themselves and recapture the Holy Land from the Muslims. He promised the crusaders both spiritual and material rewards for their work. The crowd enthusiastically responded with shouts of "God wills it!" An intense desire to fight for Christianity gripped western Europe, and thousands of people joined the cause.

Not all the crusaders joined the expeditions for religious reasons. The French knights wanted more land. Italian merchants hoped to expand trade in Middle Eastern ports. Many priests and monks wanted valuable religious relics. Large numbers of poor people joined the expeditions simply to escape the hardships of their normal lives.

The First Crusade (1096-1099). Following Pope Urban II's call for a crusade, an enthusiastic preacher known as Peter the Hermit and a knight called Walter the Penniless led a group that rushed ahead of the official expedition. This group, known as the Peasants' Crusade, was untrained and undisciplined. Its members demanded free food and shelter as they travelled through eastern Europe toward Constantinople (now Istanbul, Turkey). Because these crusaders often stole what they wanted, many of them were killed by angry Europeans. The Turks slaughtered most of the rest in Asia Minor. See Peter the Hermit.

The main armies sent by Pope Urban II consisted chiefly of well-trained French and Norman knights. The key leaders included Godfrey of Bouillon, Raymond of Toulouse, Robert of Flanders, and Bohemond of Tarento. At Constantinople, Byzantine forces joined the

crusaders. In 1097, the combined army defeated the Muslims near Nicaea, in what is now northwest Turkey.

Then the army divided, and the western Europeans marched toward Jerusalem, fighting many bloody battles along the way. The most difficult was the siege of Antioch, in northern Syria (now in Turkey). Many crusaders died there, in battle or from hunger, and many others deserted. After Antioch had been captured, the crusaders were attacked there by the Turks. However, the discovery of a lance said to be the one that wounded Jesus on the cross inspired the crusaders, and they won a great victory. The Europeans arrived at Jerusalem in the summer of 1099. They recovered the Holy City after six weeks of fighting. Most of the crusaders then returned home. The leaders who remained divided the conquered land into four states. These states, called the *Latin States of the Crusaders*, were the County of Edessa, the Principality of Antioch, the County of Tripoli, and the Kingdom of Jerusalem.

The Second Crusade (1147-1149). The Christian forces in the Holy Land grew weak. In 1144, the Turks conquered the County of Edessa. The threat to the other Christian states brought about the Second Crusade. The spirited preachings of the French religious leader Bernard of Clairvaux inspired western Europeans to defend the Latin States against the Muslims.

King Louis VII of France and King Conrad III of Germany led the armies of the Second Crusade into Asia Minor. But their armies did not cooperate, and the Muslim forces defeated them before they reached Edessa.

The Third Crusade (1189-1192). The Muslims continued to attack the Christians in the Holy Land. By 1183, Saladin, the sultan of Egypt and Syria, had united the Muslim areas around the Latin States. In 1187, Saladin easily defeated a Christian army at the Battle of the Horns of Hattin, and triumphantly entered Jerusalem. Only the coastal cities of Tyre, Tripoli, and Antioch remained in Christian hands.

The loss of Jerusalem led to the Third Crusade. The important European leaders of the Third Crusade included the German emperor Frederick I (called Barbarossa), King Richard I (the Lion-Hearted) of England, and King Philip II (Augustus) of France.

Frederick drowned in 1190 on his way to the Holy Land. Quarrels among Richard, Philip, and other leaders limited the crusaders' success. The Europeans conquered the Palestinian port cities of Acre (now Akko)



A crusader's fortress, the Krak des Chevaliers, was powerfully built to withstand Muslim attacks. This castle, which stands in Syria, was built by the Knights of St. John (Knights Hospitallers) in the 1100's. Such fortresses could house several thousand fighting men and their servants.

First and Third crusades

This map shows where the First and Third Crusades started and the routes the crusaders followed to the Holy Land. The First Crusade began in 1096 and ended in 1099. The crusaders succeeded in capturing Jerusalem. They also established the Latin States of the Crusaders: *Edessa, Antioch, Tripoli, and Jerusalem*. The Third Crusade began in 1189 and ended in 1192. The crusaders failed to recapture Jerusalem, but won an agreement with the Turks to permit Christians to visit the city.

0 200 400 Miles
0 200 400 800 Kilometres



and Jaffa in 1191. But after the capture of Acre, Philip returned home to plot against Richard. Richard attempted to recapture Jerusalem, but failed. Before Richard left for home, however, he negotiated a treaty with Saladin. As a result of this treaty, the Muslims let Christian pilgrims enter Jerusalem freely.

The Fourth Crusade (1202-1204) resulted from the failure of the Third Crusade to recapture Jerusalem. The crusaders became involved in affairs of the Byzantine Empire, however, and never reached their original goal.

Pope Innocent III persuaded many French nobles to take part in the Fourth Crusade, which he thought should go to the Holy Land. But the crusade's leaders decided to attack Egypt instead in order to split Muslim power. The crusaders bargained with traders from Venice, a powerful Italian port city, to take them by ship to Egypt. Only about a third of the expected number of crusaders arrived at Venice, and they could not pay the costs of the ships. However, the Venetians offered to transport the crusaders if the crusaders helped them attack Zara, a city in what is now Croatia. The crusaders accepted the offer.

Meanwhile, a refugee Greek prince named Alexius claimed that his father, Isaac, was the rightful ruler of the Byzantine Empire. The crusaders agreed to help him regain the empire in return for money and other aid in reconquering the Holy Land. In 1203, they seized Constantinople and made Isaac and Alexius co-emperors. But Alexius could not fulfil his promises to the crusaders. In 1204, the crusaders captured Constantinople and put Count Baldwin of Flanders on the Byzantine throne. This Latin Empire of Constantinople lasted until 1261.

The Children's Crusade (1212) was one of the strangest and most tragic events in the history of the Crusades. Thousands of boys and girls from about 10 to 18 years old became convinced that they could recover Jerusalem. They believed God would deliver the Holy City to them because they were poor and faithful. Children from France formed one part of the group, and children from Germany the other. They expected God to part the waters of the Mediterranean Sea so that they could cross safely to Jerusalem.

None of the children reached the Holy Land. Many starved or froze to death during the long march south to the Mediterranean. When the expected miracle did not occur, the youngsters who survived the terrible journey to the sea returned home in shame. Others got aboard ships going to the East and either were drowned in storms at sea or sold into slavery by the Muslims.

Other Crusades continued in the 1200's. In the expedition known as the Fifth Crusade (1217-1221), the Christians captured the town of Damietta in Egypt. But other efforts failed, and they soon gave up Damietta in exchange for a truce.

Emperor Frederick II of the Holy Roman Empire led the Sixth Crusade (1228-1229). To the displeasure of the pope, he negotiated a peace treaty with the Muslim sultan. The sultan then gave Jerusalem to the Christians.

Jerusalem remained Christian until the Muslims seized it again in 1244. The fall of Jerusalem caused King Louis IX of France (Saint Louis) to lead the Seventh Crusade (1248-1254). Louis revived the idea of winning the Holy Land by attacking cities in Egypt. But his expedition became disorganized, and the Muslims captured Louis and his army. The Muslims freed the king in exchange for a huge ransom. Before returning to France, Louis spent four years in the Holy Land trying to strengthen the Christian forces there. In 1270, he led the Eighth Crusade against the Muslims. He landed his army at Tunis. In northern Africa, Louis died soon afterward, however, when a plague broke out among his troops.

Meanwhile, in the East, the Muslims continued to gain Christian territory. They captured Antioch in 1268. Finally, in 1291, they seized Acre, the last Christian centre in Palestine. By this time, Europeans were losing interest in the Holy Land. Several weak attempts to organize crusades during the 1300's and 1400's failed. Europe was turning its attention westward to the Atlantic Ocean and beyond. In 1492, Christopher Columbus sailed to the New World. The European countries looked toward America to satisfy their ambitions to expand. They left the Holy Land to the Muslims.

Results of the Crusades. The crusaders failed to accomplish their main goals. They recaptured the Holy

Land for a time but could not establish lasting control over the area. Western and eastern Christians united to fight the Muslims. But relations between the two groups of Christians, especially as a result of the Fourth Crusade, became so bitter that they led to a heritage of hate. The Byzantine Empire fell to the Ottoman Turks in 1453. Also, the prestige of the pope declined because some popes used the Crusades for both personal and political gain.

However, the Crusades also enriched European life. For example, they further stimulated economic growth by bringing increased trade between cities that bordered the Mediterranean Sea. The Italian cities of Venice, Genoa, and Pisa prospered and grew powerful by carrying crusaders and their supplies to the Middle East, where these cities gained privileges in territories conquered during the Crusades. Goods from Asia passed through these territories on the way to the cities in Italy.

Western Europeans also learned how to build better ships and make more accurate maps during the Crusades. They began to use magnetic compasses to tell directions. The Crusades were of only modest importance compared to the great commercial expansion or the rise of monarchies in western Europe. In the minds of the people of the crusading era, however, the Crusades seemed very important.

Historians once expressed the view that the crusaders who returned to Europe acquainted Westerners with the goods and ways of life in the East and that this contact greatly influenced life in the West. As a result of the Crusades, historians once argued, Europeans were introduced to such items as sugar, silk, velvet, and glass mirrors. Modern historians, however, reject these arguments. They say that Europeans had known of sugar, silk, velvet, and glass mirrors before the Crusades. These historians point to a wide amount of interchange between Muslims, Byzantines, and Europeans many years before the Crusades. Venice, above all, had long served as a link between the East and West.

The Crusades did, however, influence the intellectual life of western Europe, especially in the areas of literature and music. Many writers during the Renaissance were inspired to produce histories of the Crusades in either prose or verse. Some romantic legends grew up around the Crusades. For example, Torquato Tasso, an Italian poet of the late 1500's, wrote a famous epic poem dealing with the First Crusade called *Gerusalemme liberata* ("Jerusalem liberated").

In the field of music, returning crusaders brought to western Europe such instruments as the *shawm*, which was a forerunner of the oboe, and the *lute*, a stringed instrument that had already been brought into Spain by the Arabs.

Related articles in *World Book* include:

Bernard of Clairvaux, Saint	Frederick II (Holy Roman emperor)	Louis (IX, of France)
Feudalism	Innocent (III)	Muslims
Flag (pictures historical flags of the world)	Knights and knight-hood	Philip (II, of France)
Frederick I (Holy Roman emperor)	Knights of Saint John	Richard (I, of England)
	Knights Templars	Saladin
		Urban (II)

Crusoe, Robinson. See **Robinson Crusoe.**

Crustacean is an invertebrate animal with many jointed legs. A crustacean has no bones. A shell called an *exoskeleton* covers its body. Crabs, crayfish, lobsters, and shrimp are crustaceans, as are barnacles, water fleas, and wood lice.

There are about 42,000 species of crustaceans. The largest crustacean, the giant spider crab of Japan, measures up to 3.5 metres long between its outstretched claws. The smallest species, such as copepods and water fleas, may be less than 1 millimetre long. Most kinds of crustaceans live in salt water, but some inhabit fresh water. A few kinds, including certain crabs and wood lice, live on land.

Crustaceans play a major role in aquatic ecology. In most aquatic environments, diatoms and other microorganisms are the basic food producers. Many small crustaceans feed on these microorganisms. The small crustaceans, in turn, serve as food for fish and other larger aquatic animals. Crustaceans thus form a key link between food-producing microorganisms and the larger animals in the aquatic food chain.

People in many parts of the world eat crabs, lobsters, shrimp, and other crustaceans. On the other hand, some kinds of crustaceans cause problems for people. For example, certain marine wood lice burrow into, and eventually destroy, wooden wharves. Barnacles attach themselves to the hulls of ships and greatly reduce the vessels' speed. Certain crabs and other crustaceans damage rice crops by burrowing into the dikes that surround rice paddies, or by eating the young plants.

The body of a crustacean

Outer body. The body of most adult crustaceans has three main parts, each of which consists of many segments. These three parts are (1) the head, (2) the thorax, and (3) the abdomen.

Crustaceans have two pairs of antennae, which extend from the head. The head also includes the mouth, three pairs of jaws, and the eyes. The eyes may be even with the surface of the head or at the end of stalks.

Each segment of the thorax has a pair of legs. Most crustaceans have 6 to 14 pairs of legs. A few species have more, and some have less. Crustaceans use some of their legs mainly for swimming or walking. Other legs may be pincers used for catching food, for fighting, or for other activities.

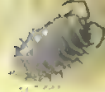
The abdomen of most species of crustaceans lacks legs. But *malacostracans*, a major group that includes lobsters and shrimp, have small abdominal legs. These legs are used for swimming, for breathing, and, in the females of some species, for carrying eggs. Many malacostracans also have a flattened tail, which they snap rapidly to swim backward.

A crustacean's exoskeleton protects and supports the internal organs. The exoskeleton may be soft or very hard. It is soft and thin at the joints to allow for bending. Some species have a shield of exoskeleton called a *carapace* that extends from the back of the head over the thorax.

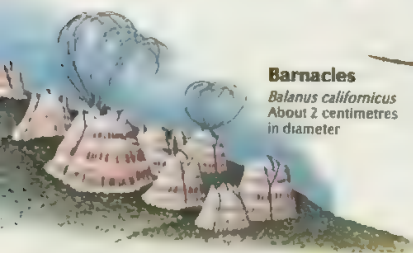
Internal organs of crustaceans resemble those of insects (see **Insect** [Internal organs]). In most kinds of crustaceans, a heart pumps the blood throughout the body. Some small species of crustaceans have no heart, and their body movements promote circulation of the blood.



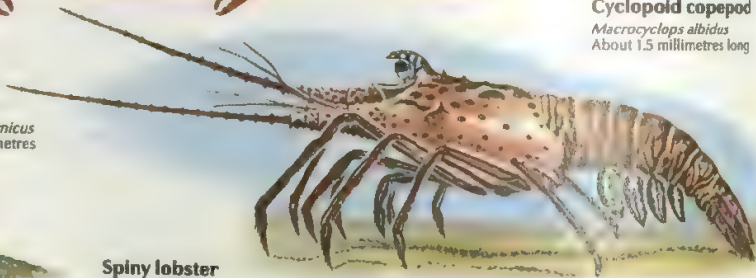
Giant spider crab
Macrocheira kaempferi
About 3.5 metres
between outstretched claws



Isopod
Parcello scaber
About 1.5 centimetres long



Barnacles
Balanus californicus
About 2 centimetres
in diameter



Spiny lobster
Panulirus pencillatus
About 35 centimetres long

Cyclopoid copepod
Macrocylops albidus
About 1.5 millimetres long

Crustaceans include a wide variety of animals. The largest crustacean, the giant spider crab, measures up to 3.5 metres long between its outstretched claws.

A crustacean's digestive system has three main parts. In malacostracans, food is ground up in the *foregut* and is further digested in the *midgut*, or stomach. The *hindgut*, or intestine, compacts and stores undigested materials until they are eliminated from the body.

Crustaceans have a small brain. It is connected to a nerve cord that extends along the underside of the body. Clusters of nerve cell bodies along the cord have some control over various activities.

Most crustaceans, unlike land-dwelling insects, breathe through gills. However, most small species have no gills. They breathe through their skin.

Senses. Most adult crustaceans have a pair of *compound eyes*. These eyes have many separate lenses and can easily detect movement (see **Compound eye**). Many species also have a *simple eye*, which senses light but does not form an image. Most young crustaceans, and the adults of copepods and a few other species, have only a simple eye.

Tiny hairlike *setae* cover various parts of the body. Certain of them are sensitive to touch, smell, and taste. These sensory setae are concentrated on the antennae, mouthparts, and pincers.

The life of a crustacean

Reproduction. Among most species of crustaceans, the male deposits sperm on the female's shell. The sperm then fertilizes the eggs as the female lays them. The number of eggs ranges from a few to many thousand. In most species, the female carries the eggs on certain parts of her body until they hatch.

Growth and development. Most kinds of crustaceans hatch as *larvae*, which are immature animals that do not resemble the adults. The larvae go through several body changes before they look like their parents. In a few species, including beach hoppers and wood lice, the young hatch as miniature adults.

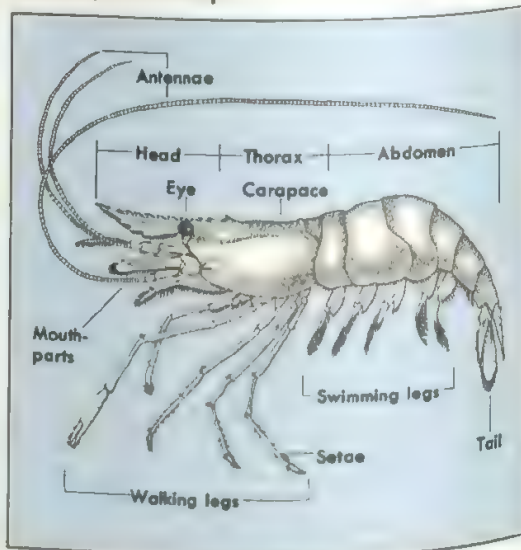
A crustacean's exoskeleton does not expand, and so

the growing animal repeatedly sheds its old shell and grows a new, larger one. The shedding process is called *moulting*. Before moulting begins, a soft, thin new exoskeleton forms beneath the old shell. The old exoskeleton then splits, and the animal works its way out of it. The crustacean soon swells to a larger size before the new shell hardens.

With each moult, a larva adds segments and legs and becomes increasingly like an adult. In some species, the body form may change completely in a single moult. Many kinds of crustaceans continue to moult throughout life, but others stop after reaching maturity.

If certain parts of a crustacean's body are damaged or lost, they may be repaired or replaced through a proc-

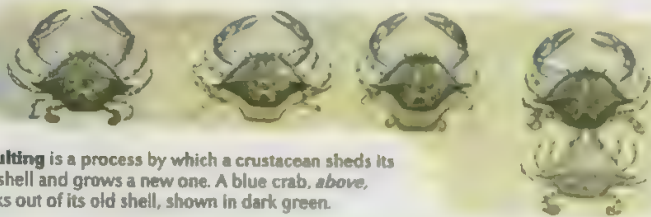
The body of a shrimp



Interesting facts about crustaceans



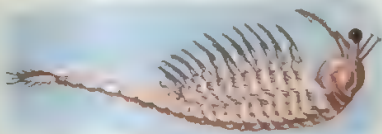
The eyes of a fiddler crab, *above top*, are located on the ends of stalks. Those of a beach hopper, *above bottom*, are even with the surface of the head.



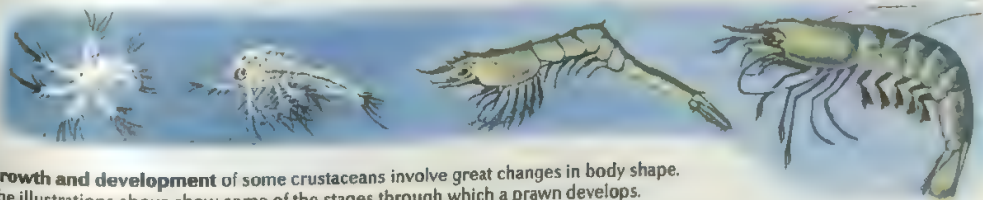
Moulting is a process by which a crustacean sheds its old shell and grows a new one. A blue crab, *above*, backs out of its old shell, shown in dark green.



Regeneration. A crustacean can replace lost body parts. After a fiddler crab loses a claw, *above left*, its other claw enlarges while a new one grows, *right*.



The legs of a brine shrimp, *above left*, filter food particles from the water as the animal swims. A lobster, *above right*, uses its front legs to catch prey, and the others to walk.



Growth and development of some crustaceans involve great changes in body shape. The illustrations above show some of the stages through which a prawn develops.

ess called **regeneration**. After a crustacean loses an antenna, a claw, or a leg, a replacement part may develop and appear during the next moult. The replacement part is small at first. It enlarges with successive moults. Some crustaceans, such as crabs and lobsters, can voluntarily detach a limb that has been caught by an enemy.

Food and habits. Some kinds of crustaceans live as parasites on other animals. Others, including crabs, crayfish, and lobsters, prey on various water creatures. Many of these species also eat the remains of animals and plants. Copepods, water fleas, and the larvae of various crustaceans drift through the water and feed on floating microscopic organisms. In turn, these crustaceans are eaten by barnacles, krill, and other crustaceans, and by many kinds of fish. Krill, in turn, are eaten by certain whales. Various other crustaceans become the prey of birds and land mammals.

Crustaceans live in a variety of habitats. Some drift

through the water constantly. Others prowl along the bottom of a body of water and hide among rocks or weeds. Some find shelter in a sponge or coral, or inside the shell of a mollusc. Crabs and some other crustaceans burrow into mud or sand for safety. Barnacles attach themselves to rocks along the seashore, as well as to turtles, whales, ships, and wharves. Most land crustaceans live under rocks or fallen leaves, or in burrows and other damp places.

Scientific classification. Crustaceans make up the class Crustacea, phylum Arthropoda. Crabs, crayfish, lobsters, shrimp, and wood lice belong to the subclass Malacostraca. Barnacles and copepods are in the subclass Maxillopoda, and water fleas belong to the subclass Branchiopoda.

Related articles in *World Book* include:

Arthropod
Barnacle
Blue crab
Copepod

Crab
Crayfish
Fiddler crab
Hermit crab

Krill
Lobster
Shrimp

Spider crab
Water flea
Wood louse

Cryobiology is the study of how extremely low temperatures affect living things. Cryobiologists use temperatures that range from 0°C , the freezing point of water, down to just above -273.15°C , which is absolute zero (see **Absolute zero**). The word *cryobiology* comes from the Greek *kryos* (cold or frosty) and *biology* (the science of living things).

Cryobiologists are chiefly concerned with freezing living matter to preserve it for future use. The freezing must be done to keep the cells alive. Cryobiologists use a liquid gas, usually nitrogen, to get temperatures far below normal freezing. Cells kept cold in the liquid gas stop working. But they stay alive and unchanged in a state of "suspended animation." They can remain in this state without harm for long periods. After thawing, the cells resume their normal work almost at once.

The freezing of tissues such as skin, eye corneas, and blood makes it possible to store these parts in "banks." Doctors may use skin from such a bank to graft onto a badly burned patient. They use healthy corneas that have been stored to replace diseased or damaged ones. Blood banks previously could keep blood only for three weeks before it spoiled. But frozen whole blood can be stored indefinitely now.

In *cryosurgery*, surgeons use extreme cold to destroy tissue. For example, they can perform a "bloodless" operation by using instruments equipped with *freezing tips*. When they insert a cooled tip into diseased tissue, it kills the unwanted tissue. A shield around the remainder of the instrument protects healthy tissue.

Food industries use the techniques of cryobiology to preserve food. Manufacturers can freeze and store foods indefinitely without harming the flavour, consistency, or nutritional value.

Cryogenics is the study of extremely low temperatures. It includes the development of techniques that produce and maintain such temperatures for industrial and scientific use. Temperatures of primary interest in cryogenics range from about -120°C to almost *absolute zero*, -273.15°C . Absolute zero is, theoretically, the lowest temperature a gas can reach. Cryogenic temperatures are usually given on the *Kelvin scale*, the standard for scientific temperature measurement. Absolute zero has a value of zero on the Kelvin scale.

The word *cryogenics* comes from two Greek words meaning *cold* and *produce*. Physicists first produced extremely cold temperatures in the 1870s with the development of *liquid air* (see **Liquid air**).

In 1963, scientists cooled copper nuclei to the lowest temperature reached so far—almost one millionth kelvin above absolute zero. The nuclei were magnetized at low temperatures in a magnetic field. When the magnetic field was removed, the nuclei became demagnetized and their temperature dropped to near absolute zero.

The first industrial use of cryogenics was the production of liquid air, a primary source of liquid oxygen and liquid nitrogen. Certain aircraft and spacecraft carry liquid oxygen that can be converted into gaseous form for crews to breathe on long flights. Other uses of liquid oxygen include the manufacture of synthetic gases and the treatment of waste water. Liquid oxygen and liquid hydrogen also are used in some rocket propellants and in fuel cells. Liquid nitrogen serves as a refrigerant. In addition, industry uses cryogenic techniques in the

liquidizing, transportation, and storage of natural gas and the freezing, transportation, and storage of various kinds of food.

Cryogenics has provided doctors with ways to freeze living parts of the body, such as blood and eye corneas, for future use. Other medical uses of cryogenic techniques include freezing organs during operations and destroying diseased tissue (see **Cryobiology**).

In physics research, the development of the liquid hydrogen bubble chamber provided a major tool for the study of subatomic particles (see **Bubble chamber**). Processing at cryogenic temperatures has made isotope-separation techniques more efficient for nuclear energy research. Cryogenics also contributed to the discovery of *superconductivity*, the ability of some metals to conduct electricity with no resistance at temperatures near absolute zero. Superconducting magnets cooled with liquid helium are used in medicine in *magnetic resonance imaging*, a technique that produces images of the internal organs of the body (see **Magnetic resonance imaging**).

See also **Absolute zero**; **Superconductivity**.

Cryosurgery. See **Cryobiology**; **Surgery (Technique)**; **Medicine (picture: Cryosurgery)**.

Cryotron is a tiny electronic device that can be used as a switch or an amplifier. Cryotrons are only about 2.5 millimetres long. They are so small that 100 of them will fit into a thimble. The small size of the device makes it possible to greatly reduce the size of computers and other electronic apparatus.

Cryotrons work on the principle of *superconductivity*. This is the ability of some metals, such as lead, to conduct electric current with no resistance at temperatures below -215°C , or near absolute zero (see **Absolute zero**). A container of liquid helium surrounds cryotrons and cools them to these temperatures. However, a magnetic field can destroy superconductivity. This causes resistance to return to superconductive material so that little or no current will flow.

In a cryotron, a superconductive coil of fine wire is wound around another superconductive wire. A flow of current through the coil produces a magnetic field (see **Electricity (Magnetism)**). The other wire will conduct current with no resistance so long as no current flows through the coil. By regulating the flow of current in the coil, the flow in the second wire can be turned on or off. In this way, a cryotron acts as a switch or amplifier. See **Electronics**.

Dudley A. Buck, a scientist at the Massachusetts Institute of Technology, in the U.S.A., began work on the cryotron in 1954, and completed it in 1957.

See also **Superconductivity**.

Crypt is an underground room or vault. It usually refers to a vault under a church. The word comes from the Greek *kryptein* (to hide). Saints and martyrs were often buried in crypts. Chapels and altars were sometimes built over the spot where their bones were supposed to lie.

One famous crypt is that of Saint Helena in Jerusalem. Legend says she found there the cross on which Christ died. Other famous crypts include those of Saint Peter's in Rome, of Saint Nicholas at Bari, Italy, of Canterbury Cathedral, in Kent, England, and of Glasgow Cathedral, Scotland. See also **Altar**; **Catacombs**.

Cryptography. See Codes and ciphers.

Crystal is a solid that is composed of atoms arranged in an orderly pattern. Most nonliving substances are made up of crystals. For example, metals and rocks consist of crystals, as do snowflakes, salt, and sugar.

Well-developed crystals have a distinctly regular shape as a result of their geometrically ordered arrangement of atoms. Such crystals have smooth, flat surfaces, which intersect to form sharp edges. These surfaces, called *crystal faces*, show definite symmetrical relationships. The faces of crystals of the same substance always meet at the same angle regardless of the shape and size of the crystals.

The scientific study of crystals is called *crystallography*. Crystallographers measure the angles between crystal faces and analyse the symmetrical arrangements of such surfaces. They also examine and identify the atomic structures of crystals with the aid of *transmission electron microscopes* and *X-ray diffraction techniques* (see X rays [In scientific research]).

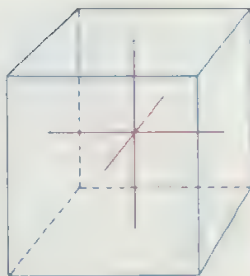
Crystallization is the process by which nonliving matter grows into crystals. Crystals may form from vapours, solutions, or *melts* (molten materials). When either temperature or pressure is lowered or evaporation occurs, certain atoms in such substances move close together and join. In most cases, they do so on a *crystallization nucleus*, an impurity or a tiny piece of crystal consisting of a particle or cluster of atoms. The atoms collect on the nucleus and arrange themselves into structural units called *unit cells* to form a crystalline solid. A crystal increases in size by adding atoms to its surfaces in an expanding network of unit cells. See *Mineral* (Inside minerals).

In a few cases, crystals develop smooth, mirrorlike faces. Such crystals are said to be *euohedral*. In nature, euohedral crystals rarely occur because they form only in an unconfined space where they can grow without touching other crystals. Most crystals are *subhedral*—that is, they have poorly formed faces that are rough or pitted. Some crystals, called *anhedral* crystals, have no faces at all. Most rocks are composed of anhedral crystals.

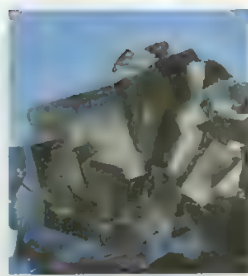
Classifying crystals. Crystals are classified according to *symmetry*, a balanced arrangement of faces. There are three basic features of crystal symmetry—plane of symmetry, axis of symmetry, and centre of symmetry.

A *plane of symmetry* is an imaginary plane that divides a crystal into identical halves. An *axis of symmetry* is an imaginary line through the centre of a crystal. When a crystal is rotated 360° about this axis, identical faces will appear from two to six times. If identical faces recur twice, the axis is a *twofold* axis of symmetry. If they reappear three times, the axis is a *threefold* axis. A crystal has a *centre of symmetry* if opposite sides are identical. Most crystals have a centre of symmetry.

All crystals can be grouped into one of 32 possible combinations of symmetry. These combinations, in turn, can be classified into seven general crystal systems. These systems are (1) isometric, (2) tetragonal, (3) hexagonal, (4) rhombohedral, (5) orthorhombic, (6) monoclinic, and (7) triclinic. Each system may be described in terms of three imaginary axes, called *crystallographic axes*, which intersect in the centre of a crystal.



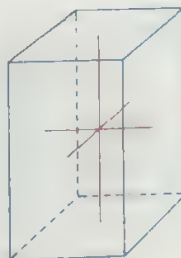
Isometric crystal



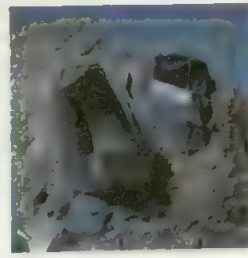
Pyrite

Isometric system. Crystals in this system have three axes of equal length that are perpendicular to one another. The simplest isometric crystal is a cube. Another form is the octahedron, which has eight sides consisting of equilateral triangles. Such minerals as galena, garnet, and pyrite crystallize in this system.

Tetragonal system. Tetragonal crystals have three axes that intersect at right angles. Two of the axes are of equal length. The simplest form of tetragonal crystal is a prism in which the sides are rectangular and the top and bottom are square. Other tetragonal crystals resemble



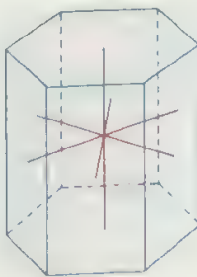
Tetragonal crystal



Rutile

eight-sided pyramids. Their sides are made up of identical *isosceles* triangles, which are triangles with two equal sides. The minerals cassiterite, rutile, and zircon crystallize in the tetragonal system.

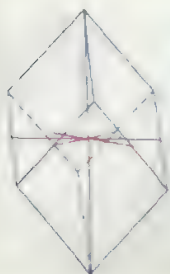
Hexagonal system. Hexagonal crystals have four axes. Three of the axes are of equal length and lie in a horizontal plane with a 120° angle between one another. The fourth axis is perpendicular to the others and may be of any length. The simplest hexagonal crystal is a prism that has six rectangular faces parallel to the fourth axis. The



Hexagonal crystal



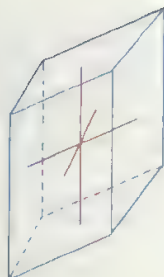
Apatite



Rhombohedral crystal



Quartz



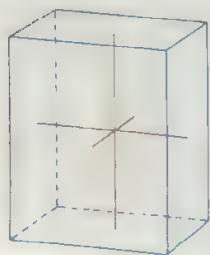
Triclinic crystal



Plagioclase feldspar

minerals apatite, beryl, graphite, and molybdenite form in this system.

Rhombohedral system. Some crystallographers consider the rhombohedral system a subdivision of the hexagonal system because both systems can be defined in terms of the same axes. However, there is one major difference between them. The vertical axis of a rhombohedral crystal is a threefold symmetry axis, but that of a hexagonal crystal is a sixfold axis. The simplest crystal in the rhombohedral system has six rhomboidal faces, each consisting of an equal parallelogram. This system includes crystals of calcite, dolomite, and quartz.



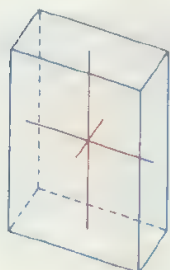
Orthorhombic crystal



Barite

Orthorhombic system. Orthorhombic crystals have three axes of unequal length that intersect at right angles. The simplest crystal of this type is an orthorhombic prism with three sets of unequal rectangular faces that meet at right angles. Aragonite, barite, topaz, and certain other minerals crystallize in this system.

Monoclinic system. Monoclinic crystals have three axes of different lengths. Two of the axes are perpendicular to each other, but the third is inclined. A simple



Monoclinic crystal



Gypsum

monoclinic crystal has two rhomboidal faces and four rectangular ones. The top and bottom surfaces are inclined. Many compounds, including the minerals gypsum, hornblende, orthoclase, and pyroxene belong to this system.

Triclinic system. Triclinic crystals have three axes of unequal length. None of the axes are perpendicular. The faces of these crystals are all different and do not meet at right angles. Plagioclase feldspars and a few other minerals form in this system.

See also Gem; Mineral; Snow.

Crystal. See Glass.

Crystal ball. See Fortunetelling.

Crystal Palace was an iron and glass building designed by Joseph Paxton for the Great Exhibition held in London in 1851. The palace was first erected in Hyde Park. It was prefabricated from iron girders and arches. The building was 1,851 feet (564 metres) long, to commemorate the year of the exhibition. In 1852, it was dismantled and rebuilt at Sydenham, in south London. The rebuilt structure, called Sydenham Palace, had additional end-towers by Isambard Kingdom Brunel. The building burned down in 1936. The site in south London became known as Crystal Palace. Today, the Crystal Palace grounds have a National Sports Centre, which has facilities for athletic activities.

Crystal set. See Radio (How radio programmes are received; picture: A "crystal" radio).

Crystalline lens. See Eye (The uveal tract).

Crystallography. See Crystal.

CSIRO, the Commonwealth Scientific and Industrial Research Organization, is Australia's largest scientific research body. It is a statutory corporation that was set up by the Australian federal government.

Organization. CSIRO has a total staff of 7,300 people. These people work in more than 100 laboratories and field stations throughout Australia. About one-third of the staff are scientists.

CSIRO is governed by an executive. The research work of CSIRO is carried out in 5 institutes, made up of 41 divisions, and 2 smaller units with related interests.

More than four-fifths of CSIRO's income comes directly from the Australian government. Trust funds tied into or having a particular interest in specific primary industries, as well as other contributors, provide much of the remainder. The organization has a total budget of over 400 million Australian dollars.

Work. CSIRO's research seeks to solve problems facing Australia's industries. But it also extends to other areas that affect every Australian, including the environ-



Crystal Palace was built in Hyde Park, London, to house the Great Exhibition of 1851, as shown in this contemporary print. It was re-erected in south London but was destroyed by fire in 1936.

ment, human nutrition, energy, and water resources. It is also involved in areas of special relevance to Australia, such as the oceans around the continent and astronomy of the southern skies.

CSIRO is at the forefront of research aimed at developing high-technology industries. The organization has developed a remarkable multipurpose ceramic that combines exceptional toughness with a high degree of resistance to rapid temperature change. CSIRO is also investigating the industrial spin-offs from space technology developments.

CSIRO supports traditional primary and secondary industries through the use of advanced technology. For example, the organization uses satellite imagery in minerals exploration. It also uses lasers and other sophisticated technologies to maintain the legal standards of measurement used in commerce and industry.

CSIRO is applying molecular biological techniques to plant and animal breeding. Scientists are also investigating the use of a chemical compound to biologically defleece sheep. They have developed a computerized management programme that tells farmers when to spray and irrigate their cotton crops. CSIRO has also developed biological methods to control noxious weeds and insect pests.

CSIRO's radio telescope at Parkes, New South Wales, played a key role in the European Space Agency's Giotto mission to Halley's comet in 1986. CSIRO biologists have demonstrated the adverse effects of alcohol on the human fetus. They are also combining with staff of two other institutions to study the nature and structure of the influenza virus and the synthesis of potential drugs to treat it. Physicists have produced an alloy capable of storing hydrogen fuel for motor vehicles.

History. The CSIRO was established by the Science and Industry Research Act of 1949. Under the act, it replaced the former Council for Scientific and Industrial Research (CSIR), established in 1926. In 1978, CSIRO was restructured by amendments made to the 1949 act.

See also **Clunies-Ross**.

CSR is one of the largest Australian public companies. It markets all Australia's sugar exports, refines 96 per cent of all refined sugar consumed in Australia, and fi-

nances the Queensland sugar crop. The company also manufactures various types of building materials and has interests in ready-mixed concrete, chemical, and mining companies. A British businessman, Edward Knox, founded CSR in 1855. The company began milling in northern New South Wales in the 1870s, and then expanded into Queensland. The company changed its name from the Colonial Sugar Refining Company Limited to CSR Limited in 1973.

Ctenophore is a small transparent sea animal that lives in all the oceans of the world. Ctenophores are also called *comb jellies* and *sea gooseberries*. The body of a ctenophore may be shaped like a ball, a thimble, or a belt. It looks somewhat like a jellyfish. The size of most species (kinds) varies from that of a pea to a thimble. One group of species, called *Venus's girdle*, is shaped like a belt and may grow to more than 90 centimetres long.

The word *ctenophore* means a *comb bearer*. The animal gets this name from the eight bands of comblike organs on the sides of its body. The combs are made of groups of *cilia* (tiny hairlike structures). Ctenophores move slowly through the water by beating these cilia. In some species, the combs give off flashes of light.

Scientific classification. Ctenophores make up the phylum Ctenophora.

Cuahtémoc (1495?-1525) was the last Aztec Indian ruler of Mexico. He defended the Aztec capital, Tenochtitlan (now Mexico City), against the Spanish conqueror Hernando Cortes. The fall of Tenochtitlan in 1521, which followed a long siege, marked the end of the Aztec civilization.

Cuahtémoc became ruler of the Aztecs in 1520, four months after the death of his uncle, Emperor Montezuma II. In 1525, Cortes had Cuahtémoc killed because he believed the Indian leader was plotting against the Spaniards.

Today, Mexicans honour Cuahtémoc as a national hero because of his bravery in the defence of Tenochtitlan. Mexican Americans admire him as a symbol of their struggle for civil rights.

Cub. See **Bear**; **Lion**; **Tiger**.

Cub Scout. See **Scouting**.



Workers harvest sugar cane on a government-owned farm. Sugar is Cuba's chief crop.



The José Martí Monument rises 135 metres above the Plaza de la Revolución in Havana.

Cuba

Cuba is an island country in the West Indies, about 140 kilometres south of the United States. It consists of one large island and more than 1,600 smaller ones. Few people live on the smaller islands except the Isle of Youth. Havana is the capital and largest city.

Cuba is one of the most beautiful islands in the Antilles, a part of the West Indies island group. Cubans call it the *Pearl of the Antilles*. Towering mountains and rolling hills cover about a quarter of the island. The rest of Cuba consists mainly of gentle slopes and broad grasslands. Cuba has a magnificent coastline marked with deep bays, sandy beaches, and colourful coral reefs. Its moderate, frost-free climate, ample rainfall, and fertile soil have helped to make Cuba the world's largest exporter of cane sugar.

Cuba has a long history of struggle for independence and social reform. For about 400 years, Spain ruled Cuba. During this period, many Cubans died in revolts against Spanish rule. In 1898, the United States helped defeat Spain in Cuba's struggle for independence. Spain then gave up all claims to Cuba, and a U.S. military government ruled the island until 1902. In the 1930's, Cuba was controlled by a dictator, Fulgencio Batista. In 1959, Fidel Castro and a band of rebels overthrew Batista. They later set up a socialist government, with Castro as its head. Today, the Cuban government is highly centralized, and Castro has strong control. The government allows only one political party, the Cuban Communist Party.

The Castro government provides many benefits for

the people, including free medical care and free education. But Cuba's economy has developed slowly under Castro. The output of some industries has declined, and the government's attempts to increase agricultural production have been only partly successful.

Relations between Cuba and the United States became tense soon after the Castro revolution. In 1961, the United States ended diplomatic relations with Cuba. The United States maintains a naval base in Cuba at Guantánamo Bay. Cuban leaders resent the presence of the foreign naval base in their country, but the United States refuses to give it up.

Facts in brief about Cuba

Capital: Havana.

Official language: Spanish.

Area: 110,861 km². *Greatest distances:* northwest-southeast, 1,221 km; north-south, 217 km. *Coastline*—3,380 km.

Elevation: *Highest*—Pico Turquino, 1,994 m. *Lowest*—sea level.

Population: *Estimated 1996 population*—11,172,000. *density*, 99 people per km². *distribution*, 78 per cent urban, 22 per cent rural. *1981 census*—9,723,605. *Estimated 2001 population*—11,572,000.

Chief products: *Agriculture*—citrus fruit, coffee, milk, sugar cane, tobacco, vegetables. *Manufacturing*—cement, cigars, fertilizers, refined petroleum, refined sugar, rum, textiles. *Mining*—chromium, iron, nickel.

National anthem: "La Bayamesa."

National holiday: July 26, the anniversary of Fidel Castro's attack on the Moncada Army Barracks

Money: *Currency unit*—Cuban peso. One peso = 100 centavos.

Government

Under the Constitution of Cuba, adopted in 1976, the country is a socialist state and a *republic*. It is controlled by Fidel Castro and the Communist Party of Cuba. Many other countries, especially the United States, consider Cuba a dictatorship. According to Cuba's Constitution, the Communist Party is "the highest leading force of the society and of the state." The party is headed by Castro and has about 400,000 members.

The Cuban government has two major goals: (1) economic development of the nation and (2) economic and social equality among the people. Economic development has been slow in Cuba. However, the government has made great progress toward its goal of economic and social equality.

National government. The most powerful position in Cuba's government is that of the president of the Council of State. This official is both the head of state and the head of government. The president also presides over a Council of Ministers, which enforces laws, directs government agencies, and conducts Cuba's foreign policy. The Council of State has the power to enact special laws, called *decree-laws*, when the country's legislature is not in session. All decree-laws are subject to the review and approval of the legislature.

The legislature of Cuba is called the National Assembly of People's Power. It is made up of deputies elected to five-year terms by the people. The National Assembly holds two regular sessions a year. It may also meet in special sessions called by the Council of State. The National Assembly elects from its members the 31 members of the Council of State, including the president. The president, with the approval of the National Assembly, appoints the members of the Council of Ministers.

Local government. Cuba is divided into 14 provinces that are further divided into about 170 *municipalities*. One municipality, the Isle of Youth, is not a part of any province and is responsible directly to the central government. Each province and municipality has its own assembly, which passes local laws and appoints administrators.

Cuban citizens over 16 years of age may vote. The people elect the members of municipal assemblies to 2½-year terms. The municipal assemblies in a province elect the delegates to the provincial assembly. Some provincial delegates also become deputies to the National Assembly.

Courts. The People's Supreme Court is the highest court in Cuba. Other courts may also be established under the Constitution, but all courts are controlled by the Council of State. The country's State Security Courts enforce laws that ban political dissent. People who break such laws often receive long prison sentences.

Armed forces. Cuba has one of the largest and best-equipped armies in Latin America. About 118,000 men serve in the country's regular armed forces, and about 140,000 men and women are in the militia reserve army. The armed forces perform many nonmilitary services, such as harvesting sugar cane and clearing farmland. Cuban men must serve two years of active duty after 17 years of age, unless they volunteer for farm work.



Fidel Castro speaks to a large audience in Havana. A huge poster of Che Guevara and Camilo Cienfuegos, leaders in the 1959 revolution, is displayed in the background.



Cuba's flag was officially adopted in 1902, shortly after Cuba became a republic. The star stands for independence.



Coat of arms. The key means Cuba is the key to the Gulf of Mexico. The stripes are from the flag.



Cuba, which is part of the West Indies island group, lies about 140 kilometres south of Key West, Florida, U.S.A.

People

Population and ancestry. About three-quarters of the people of Cuba live in cities and towns. Havana, the capital and largest city, has almost 2 million people. Santiago de Cuba has more than 300,000 people. See the separate articles on Cuban cities listed in the *Related articles* at the end of this article. For Cuba's total population, see the *Facts in brief* table with this article.

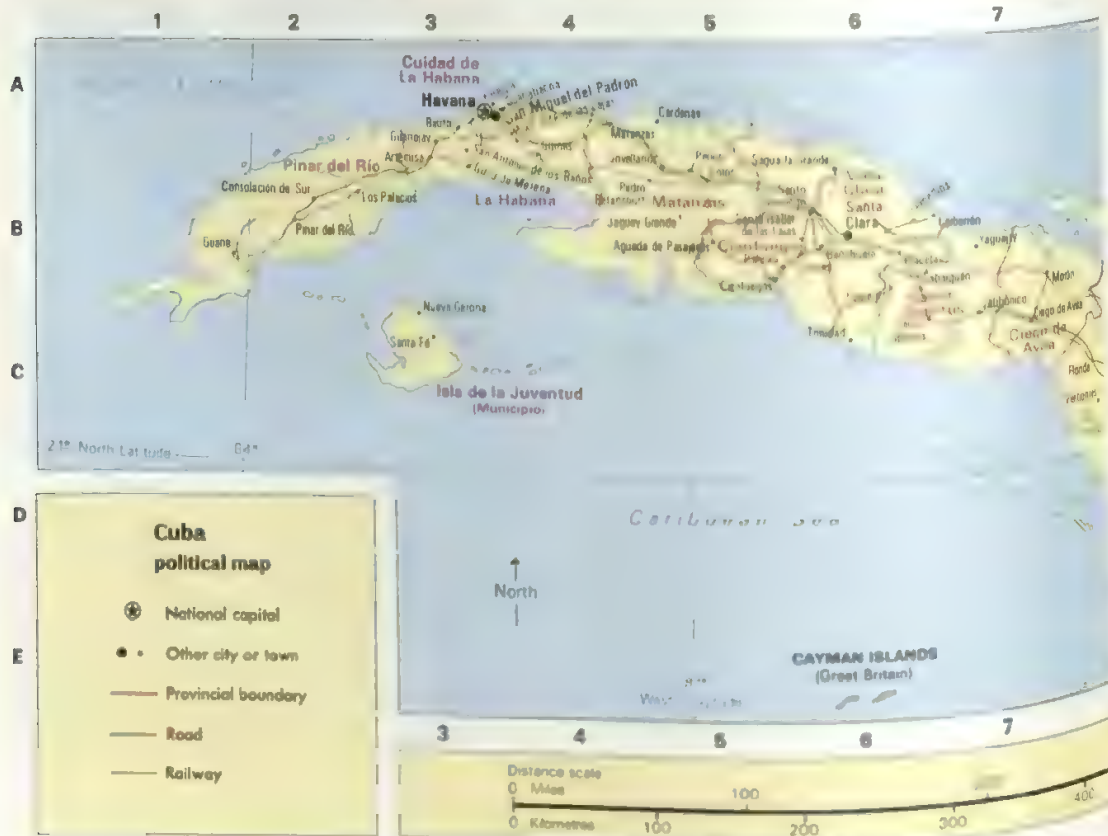
According to Cuban government records, about 75 per cent of the people are white and of Spanish descent. Most of the rest are blacks or *mulattoes* (people of mixed black and white ancestry). However, many of the people who are listed as white have a mixed ancestry. Almost all Cubans speak Spanish. Some people, especially in the cities, also speak English.

Way of life. About a quarter of the Cuban people live in rural areas. Many of them are poor. Before the Castro revolution, Cuba's government used much of the nation's economic resources to help make Havana one of the world's most luxurious and popular tourist centres. But little was done to improve life in rural areas, where many people lived largely on beans, rice, sugar cane, and root crops. Castro's government, by contrast, spends large sums of money on food, housing, and education for the rural people.

Cuba has a housing shortage. In the cities, many people live in crowded apartment buildings that need re-



Thatch-roofed houses are common in rural areas of Cuba. Many families use palm leaves to thatch their houses.



pairs. Two or more families may share an apartment. A large number of country people live in thatch-roofed huts, many of which have cement floors. The government has built much new housing, but not enough to meet the demand. Rent for government-built apartments is set at 6 to 10 per cent of a family's income.

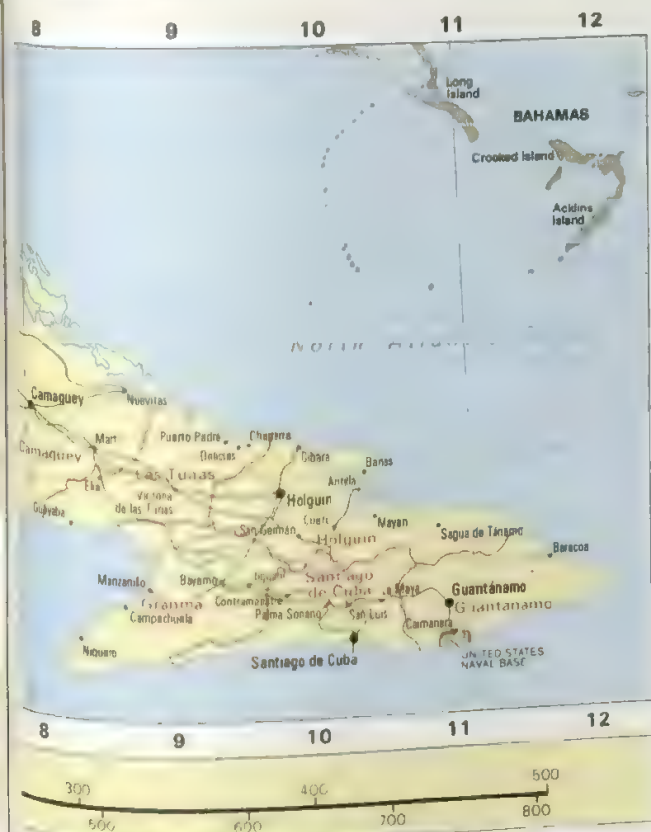
Many types of food are scarce in Cuba, and the country has a system of food rationing. The government issues coupons that entitle the holder to buy limited amounts of certain kinds of food at very low prices. Beans, beef, milk, potatoes, and rice are all sold this way. This system is intended to ensure that the poorest people can buy enough to eat. Additional food, except beef, may be purchased by those who can afford it, but at higher prices. One or two free meals a day are provided to schoolchildren and to some workers.

Cubans have a strong love for their country and its traditions. The government encourages patriotism among the people. Throughout Cuba, posters and neon lights display the revolutionary motto *Patria o Muerte, Venceremos* (Fatherland or Death, We Shall Conquer).

Most Cubans enjoy singing and dancing, especially to the lively folk music of the island. Popular Cuban dances include the cha-cha-cha, the mambo, and the rumba. Young Cubans enjoy rock music. Cubans are also enthusiastic sports fans. Favourite sports include Association football (soccer), athletics, baseball, basketball, boxing, and swimming.



Free hot lunches, often consisting of rice, beans, and meat, are served daily to Cuban schoolchildren.



Provinces

Camagüey	664,566	C	8	Cuan-	167,405	E	11
Ciego de				Güines	41,552	A	4
Avila	320,961	C	7	Güira de			
Cienfuegos	326,412	B	5	Melena	21,145	B	3
Ciudad de La Ha-				bana	1,924,886	A	3
Gramma	1,924,886	A	3	Holguín	186,013	D	10
Guantanamo	739,335	E	9	Jagüey			
Holguín	446,608	E	11	Grande	15,540	B	5
Isle de la	911,034	D	10	Jatibonico	14,863	C	7
Juventud	57,879	C	3	Ignat	15,042	D	10
La Habana	586,029	A	3	Jovellanos	20,899	B	5
Las Tunas	436,341	D	9	La Maya	13,939	E	10
Matanzas	557,628	B	5	Los Palacios	13,528	B	2
Pinar del				Manzanillo	87,471	D	9
Rio	640,740	B	2	Matanzas	21,139	D	10
Sancit	399,700	C	6	Meyari	26,850	D	11
Santiago de				Morón	40,398	B	7
Villa	509,506	E	10	Niquero	15,544	E	8
Clara	764,743	B	6	Corona	30,898	C	3

Cities and towns

Aguada de				Nuevitas	55,927	E	10
Pasajeros	12,171	B	5	Palma	9,836	B	3
Artemisa	34,024	B	3	Pedro Beltr			
Banes	31,282	D	10	court	9,033	B	5
Baracoa	35,538	D	12	Pinar del Rio	95,476	B	2
Bauta	17,734	A	3	Placetas	37,535	B	6
Bayamo	100,543	D	9	Puerto			
Cabaiguán	25,346	B	6	Padre	23,239	C	9
Calbarén	32,094	B	7	Ranchuelo	14,644	B	6
Camagüey	245,235	C	8	Remedios	16,176	B	6
Cam-				Sagua de			
Juani	17,537	B	6	Tanamo	15,327	D	11
Campechuela	14,151	E	9	Sagua la			
Cárdenas	59,501	A	5	Grande	62,741	B	6
Ciego de				San Antonio de los			
Avila	74,216	C	7	Baños	27,550	A	3
Cienfuegos	102,426	B	5	San José de			
Colón	35,098	B	5	las Lajas	27,279	A	4
Consolación del				San Luis	23,638	E	10
Sur	16,995	B	2	Sancit			
Contra-				Spirit	71,959	C	6
maestre	22,204	D	10	Santa			
Cruces	18,123	B	6	Clara	171,914	B	6
Cueto	13,552	D	10	Santiago de			
Florida	39,700	C	8	Cuba	345,772	E	10
Fomento	14,925	B	6	Santo			
Gilbara	14,511	C	10	Domingo	12,945	B	6
Guanajay	21,042	A	3	Trinidad	32,809	C	6
				Vertientes	22,440	C	8
				Victoria de			
				las Tunas	84,749	D	9

*Does not appear on map, key shows general location.
†Municipality responsible to central government.
Source 1981 census

Education. Cuban law requires children to go to school for at least six years. The government controls the schools, and education is free. About 35,000 students go to the country's three national universities, located in Havana, Santa Clara, and Santiago de Cuba.

The government has set up various adult education programmes. During the 1960's, it recruited students to teach uneducated Cubans how to read and write. Later, other education projects were established. As a result of these programmes, many adults have gone through primary school. More than 95 per cent of Cuban adults can read and write.

Religion. Most Cubans belong to the Roman Catholic Church. But the church has always been weak in Cuba, and few people attend services regularly. The government has taken over almost all church schools and has forced many priests to leave the country. The Roman Catholic Church, in turn, is often critical of the government. Two religious groups, the Jehovah's Witnesses and the Seventh-Day Adventists, have been banned, but other restrictions on religious activity have been relaxed.

Some Cubans believe in *Santería*, a religion that combines West African and Roman Catholic ceremonies. Its followers regard themselves as Catholics. They believe that Catholic saints represent African gods. Other religious groups include Episcopalians and Methodists.

Arts. The Cuban government strongly supports the arts and sponsors free ballets, plays, and other cultural events. It also provides scholarships for talented youths

to the Cubanacan, a Havana fine arts centre. The publishing company Casa de las Américas is the centre of literary activity. It publishes a literary magazine, novels, poetry, and textbooks.

The works of many of Cuba's greatest writers have attacked political and social injustice. During the 1800's, Cuba's struggle for independence from Spain inspired such writers as José Martí and Rafael Mendive. During the 1900's, the poet Nicolás Guillén, the novelist Alejo Carpentier, and other writers have described the bitter hardships of the lower classes. Also during the 1900's, Fernando Ortiz became famous for his studies of customs of Cuban blacks and of the Cuban sugar and tobacco industries. Since the Castro revolution, several young writers have become popular. They include the novelist Edmundo Desnoes and the poet Roberto Fernández Retamar. Since the early 1960's, the Castro government has imprisoned some writers for expressing views contrary to government policy.

During the 1900's, Cuban sculptors and painters have produced many outstanding works. The best-known sculptors include Teodoro Ramos Blanco and Juan José Sicre. Cuban painters have become known for their landscapes and portrayals of daily life. Leading artists include Wilfredo Lam and Cundo Bermúdez.

Cuban composers have combined African and European musical traditions. Musicians use bells, bottles, castanets, and drums to produce the unusual beat of Cuban music. Famous composers of the 1900's include José Ardévol and Alejandro García Caturla.



World-famous Havana cigars rank among Cuba's leading exports. The best cigars are made from tobacco grown in the Vuelta Abajo region in northwestern Cuba. Skilled workers, *left*, roll the cigars by hand, the traditional method of making high-quality cigars

Land

Cuba lies about 140 kilometres south of Key West, Florida, U.S.A. The Cuban mainland is the largest and westernmost island in the West Indies. With its surrounding islands it covers 110,861 square kilometres.

Surface features. Cuba has a varied landscape. Mountains and hills cover about a quarter of the island. The rest of Cuba consists chiefly of gentle slopes, rolling plains, and wide, fertile valleys.

Cuba has three main mountain ranges—the Sierra de los Órganos in the northwest, the Sierra de Trinidad in central Cuba, and the Sierra Maestra in the southeast. The highest point in Cuba, the Pico Turquino, rises 1,994 metres in the Sierra Maestra. Heavy forests, consisting chiefly of pine trees, cover the mountain regions of southeastern Cuba.

Fertile farms and pasturelands lie between the mountain ranges of Cuba. This fertile soil consists mainly of red clay. Western and central Cuba have sandy areas. Stretches of lowlands and swamps lie along the coasts. Central Cuba has limestone hills penetrated by large caves.

Rivers. Cuba has more than 200 rivers and streams. Most of them are short and narrow and too shallow for navigation. The longest river, the Cauto, flows about 240 kilometres through the southeastern part of the country. It is navigable for only about 120 kilometres.

Coastline and islands. Cuba's coastline measures 3,380 kilometres in length. It is marked with deep bays and sandy beaches and is fringed with coral islands and reefs. About 200 harbours lie along the coast. Most of



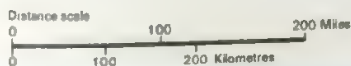
A farmer tends his oxen in Pinar del Rio, a province in western Cuba known for its rich soil and low, rolling hills.

them have narrow entrances, which protect the inner area against winds and waves. The most important harbours include Havana and Nuevitas on the north coast and Cienfuegos, Guantánamo, and Santiago de Cuba on the south coast.

More than 1,600 islands surround the Cuban mainland. The largest island, the Isle of Youth, lies about 65 kilometres off the southwest coast. It has an area of about 3,055 square kilometres. Forests cover the northern and southern parts of the Isle of Youth, and flat marshes lie in the centre.

Cuba physical map

Numerous coral reefs and small islands form bays along the Cuban coast. Cuba also has many small rivers. Pico Turquino, the country's highest mountain, rises in the Sierra Maestra.



Geographical Terms

Archipiélago.....	islands
Bahía.....	bay
Cabo.....	cape
Golfo.....	gulf
Pico.....	mountain
Rio.....	river
Sierra.....	mountain range

	National capital
	Other city or town
	Mountain peak
	Swamp
	River



Climate

Cuba lies within the northern tropics and has a semi-tropical climate. Cool ocean breezes from the northeast during the summer and warm breezes from the southeast in the winter give the island a mild climate throughout the year. Average daily temperatures in Cuba range from about 21° C in winter to about 27° C in summer. The interior has a greater temperature range than the coastal regions. But temperatures in the interior rarely fall below 10° C or rise above 32° C.

Cuba has a dry season from November to April, and a rainy season from May to October. The average annual rainfall is about 135 centimetres. Thunderstorms occur almost daily in summer. Cuba has occasional dry periods which can affect the sugar cane crop.

Violent hurricanes frequently hit the island, particularly the western half of the island, during August, September, and October. The strong winds occasionally destroy buildings and crops and create high waves that flood the coastal lowlands.

Economy

The government plans and controls Cuba's economy. It owns all industries, banks, and most small businesses. The government also owns more than 70 per cent of the farmland. The rest is privately owned.

In the early 1960's, the government began a programme to industrialize the country. The programme was only partly successful because of a lack of funds and raw materials. The government then shifted its emphasis to agriculture, especially sugar production. The Cuban economy, however, is still facing a severe crisis (see *Recent developments* section in this article).

Natural resources of Cuba include fertile soil and large mineral deposits. The best soil is in the centre of the island, where farmers grow citrus fruit, rice, sugar cane, and vegetables.

Agriculture. The Cuban government controls most farming. It operates many large *state farms*, on which workers collect wages from the state.

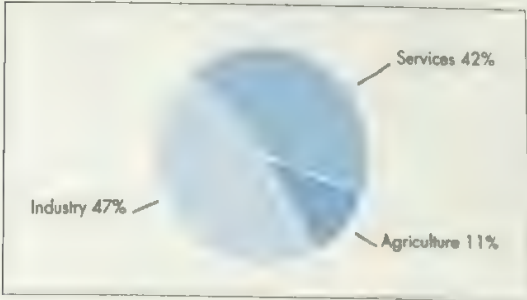


Coffee trees, like many other tropical and subtropical plants, thrive in Cuba's mild climate and fertile soil

Sugar cane has long been Cuba's chief crop. It is grown throughout the island, but the largest crops come from eastern Cuba. Tobacco, the second most important crop, comes mainly from northwestern Cuba. Other farm products include bananas, cassava, citrus fruit, coffee, pineapples, potatoes, rice, sweet potatoes, and tomatoes. Cattle raising and milk production have increased because of government programmes.

Manufacturing. Before the Castro revolution, American companies owned most Cuban industries, and almost all factory machinery and raw materials came from U.S. suppliers. In 1960, the government nationalized all foreign-owned industries. The United States broke diplomatic and trade relations with the Cuban government

Cuba's production



The net material product (NMP) is the total value of goods and services used in the production of goods produced by a country in a year. Such services include communication, trade, and transportation. NMP does not include financial services, government services, or community, social, and personal services. Cuba's NMP was 16,628,000,000 U.S. dollars in 1989

Production and workers by economic activities

Economic activities	Per cent of NMP produced	Employed workers Number of persons	Per cent of total
Manufacturing, mining, & utilities	37	757,200	22
Wholesale & retail trade	34	436,500	13
Agriculture	12	662,100	19
Construction	9	322,600	9
Transportation & communication	8	242,200	7
Community, social, & personal services*	—	1,024,800	30
Total	100	3,445,400	100

*Includes government and financial services. Sources: International Labour Organization; United Nations.

in 1961. In the early 1960's, Cuba began depending on the Soviet Union and other nations for its industrial needs.

Cuba's chief industry is food processing, especially the processing of sugar, dairy products, and flour. Cuban refineries process imported petroleum. Other manufactured products include cement, farm tools, fertilizer, iron and steel, paper, rum, shoes, textiles, tobacco products, and wood products.

Cuba has trade unions, but the government controls them. Members use the unions primarily to present complaints to factory managers. Worker assemblies handle such problems as job dismissals, transfers, and workloads. The government sets the workers' salaries.

Mining is a growing industry in Cuba. The government owns all the mines and mineral reserves. One of the world's largest nickel ore reserves lies in northeastern Cuba. The country has significant offshore oil fields and also has large deposits of limestone, used in making cement and fertilizer. Other minerals include chromium, copper, and silver.

Fishing. Cuba's fishing industry is growing rapidly. The government owns a fleet of large fishing boats. It also has organized *fishing cooperatives*, in which the members share in the profits. Important Cuban fishing ports include Caibarién, Cienfuegos, and Havana.

Trade. Cuba's chief exports are sugar and refined nickel ore. It also exports cigars, citrus fruit, fish, and rum. The country's main imports include machinery, petroleum, and grains.

Cuba spends more on imports than it collects on exports. From the early 1960's to 1991, Cuba depended on its main trading partner, the Soviet Union, for loans or gifts of billions of dollars to make up the difference. But when the Soviet Union was dissolved in 1991, Cuba lost

this important source of economic aid.

Transportation and communication. Cuba has a good road system. The main road, the Central Highway, extends from Pinar del Rio to Santiago de Cuba. Few Cubans have cars. There are more than 50 people for each car in Cuba. Most Cubans travel by bus, although railways link Cuba's main cities. About 65 per cent of Cuba's railways consist of short lines that connect sugar mills to the main lines. Fuel shortages since 1991 have led to an increase in the use of bicycles. The state airline, Cubana, flies within Cuba and to several other countries. José Martí International Airport in Havana is the largest airport.

Telegraph and telephone lines connect the major Cuban cities. Many homes do not have telephones, but the government has installed free public telephones in many cities. Cuba has an average of about 1 radio for every 5 people and 1 television set for every 13 people. About 15 newspapers are published daily.

The government controls all Cuban newspapers and radio and television broadcasts. But Cubans can pick up radio and TV broadcasts from the United States. Radio Martí, a U.S. government radio station that broadcasts programmes to the Cuban people, began operating in Miami, Florida, U.S.A., in 1985.

Early years. Christopher Columbus landed in Cuba in 1492 and claimed it for Spain. Spaniards began to settle the island in 1511, and Cuba soon became one of the richest colonies in the West Indies. Most of the settlers took up farming. They grew sugar and tobacco on large plantations and forced the indigenous people, known as "Indians", to work in the fields. Many died from diseases and harsh treatment. As the indigenous population declined, the Spaniards began to import African slaves. The first African slaves arrived in Cuba in 1517.



Pineapples are picked by a Cuban farm worker. Central Cuba produces the nation's largest pineapple crops.

History

From the mid-1500's to the late 1700's, Cuba developed slowly. Pirates raided the coasts frequently, and many colonists moved to South America.

During the late 1700's, Cuba grew prosperous again. Havana became a commercial centre as its port developed into a shipyard and naval base. Sugar and tobacco production increased, and Cuba began to sell its products to the British colonies of North America.

Cuban plantation owners imported more and more slaves during the late 1700's and early 1800's. Many owners treated their slaves brutally. In 1812, a group of slaves, headed by José Antonio Aponte, planned a revolt. The Spaniards discovered the plot and hanged Aponte and his followers.

Struggle against Spain. During the 1800's, various Cuban groups plotted revolts against the Spanish rule of their country. In 1821, José Francisco Lemus organized the first important revolutionary movement. But it collapsed by 1826. About the same time, Simón Bolívar, a South American general who became known as "The Liberator", joined several Mexican leaders to organize an army to invade Cuba and Puerto Rico and free them from Spain. The United States warned that it would support Spain against the invasions, and the military leaders dropped their plans.

During the mid-1800's, some Cubans and Americans supported a movement to *annex* (join) Cuba to the United States. Slaveholders, fearing that Spain would end slavery in Cuba, supported the annexation movement. Other groups favoured American control for economic and military reasons. The United States made several offers to buy Cuba, but Spain rejected them.

Cuba's struggle against Spanish rule led to the outbreak of the Ten Years' War in 1868. Carlos de Céspedes, a wealthy planter, headed a revolutionary group that demanded independence and the abolition of slav-

ery. Spain rejected the group's demands, and fighting followed. The war ended with the signing of the Pact of Zanjón in 1878. This treaty provided for political reforms and for the gradual abolition of slavery.

Slavery was ended in Cuba in 1886, but many Cubans still wanted independence for their country. A revolution, led by José Martí, broke out in 1895. Thousands of Cubans died in the fighting. But by 1898, Spain controlled only the major coastal cities of Cuba.

President William McKinley of the United States believed that the fighting on the island threatened American interests. He told the Spanish government to either crush the revolution or give up Cuba. In February 1898, the U.S. battleship *Maine*, which was sent to Havana to protect Americans in Cuba, exploded mysteriously. The United States blamed Spain for the explosion and, in April, declared war on Spain. Cuba's struggle for independence thus became known as the Spanish-American War. The Spanish army surrendered in August. Under the Treaty of Paris, signed on December 10, Spain gave up all rights to the island. The United States then set up a military government in Cuba. The presence of U.S. forces angered many Cubans and Americans. See **Spanish-American War**.

United States control. Cuba experienced some development under U.S. military rule. General Leonard Wood governed Cuba from 1899 to 1902. He began an important public works programme.

For many years, a deadly disease called yellow fever had plagued the Cuban people. In 1881, Carlos Finlay, a Cuban doctor, said he believed mosquitoes carried the disease. In 1900, mosquito-control programmes were begun to wipe out the disease.

Under strong pressure from the Cuban people for immediate independence, the United States decided to allow Cuba self-government. In 1901, Cuba adopted a constitution. The constitution included a set of provisions, called the *Platt Amendment*, which the United



The U.S. battleship *Maine* arrived in Havana in 1898 to protect Americans during Cuba's fight for freedom from Spain. The ship exploded mysteriously, triggering the Spanish-American War.

States insisted must be part of the document. The amendment limited Cuban independence by permitting the United States to intervene in Cuban affairs. It also allowed the United States to buy or lease land for naval bases in Cuba. Under a treaty with Cuba in 1903, the United States received a permanent lease on Guantánamo Bay and began to build a large naval base there.

In 1902, the Cuban people elected Tomás Estrada Palma as the first president of the Republic of Cuba. American troops then left the country. But they returned in 1906, after opposition to Palma's government developed into open rebellion. A civil-military government, headed by Charles E. Magoon of the United States, ruled Cuba from 1906 to 1909.

The Second Republic of Cuba was established after American forces left the country in 1909. But the new Cuban government did little to help the lower classes. A black uprising broke out in 1912. In 1917, a workers' revolt threatened to destroy the sugar mills. American companies owned many mills, plantations, and other businesses in Cuba. During both uprisings, the United States sent military forces into the country to protect American property and support the government.

The Cuban people elected Gerardo Machado president in 1924. During his campaign, Machado had attacked the Platt Amendment and had promised reforms. But after becoming president, he ruled as a dictator. In

July 1933, an army revolt forced Machado out of office. Two months later, an army sergeant named Fulgencio Batista and a group of university students and professors led a revolt that overthrew the new government. They named a five-member committee, which was headed by Ramon Grau San Martin, to govern Cuba.

The Grau San Martin government wanted to reduce U.S. influence in Cuba and make far-reaching changes. The United States refused to support it.

The Batista era. Batista felt that his best hope for power lay in winning U.S. support. He removed Grau San Martin from office in 1934. Until 1940, Batista ruled Cuba as dictator through presidents who served in name only. The United States supported Batista's government. In 1934, the United States and Cuba signed a treaty that cancelled the Platt Amendment, except for the Guantanamo Bay lease.

In 1940, Cubans adopted a new constitution and elected Batista president. The constitution prevented Batista from seeking re-election in 1944, and Grau San Martin became president again. Carlos Prío Socarras won the 1948 election.

In 1952, Batista overthrew Prío's government and again became dictator. Cuba grew prosperous under Batista. He stressed the development of light industry and encouraged foreign companies to build businesses in Cuba. Batista also established badly needed public works. But most Cubans continued to live in poverty.

The Castro revolution. On July 26, 1953, Fidel Castro, a young lawyer, tried to start a revolution against Batista by attacking the Moncada Army Barracks in Santiago de Cuba. Castro and many of his followers were captured and imprisoned. After his release in 1955, Cas-

Important dates in Cuba

- 1492** Christopher Columbus landed in Cuba and claimed the island for Spain.
- 1517** The first African slaves arrived in Cuba.
- 1668-1878** Cuban revolutionaries fought Spanish rule in the Ten Years' War. Under the Pact of Zanjón, which ended the war, Spain promised reforms.
- 1886** Slavery was abolished in Cuba.
- 1895** A revolution, led by José Martí, broke out in Cuba against Spanish rule.
- 1898** The United States defeated Spain in the Spanish-American War. Spain gave up all claims to Cuba.
- 1898-1902** A U.S. military government controlled Cuba.
- 1902** Tomás Estrada Palma became the first president of the Republic of Cuba.
- 1906-1909** American forces occupied Cuba for the second time, after opposition to Palma's government grew into open rebellion.
- 1933** A revolutionary group led by Fulgencio Batista took control of the government.
- 1934-1959** Batista controlled the government, except for the years 1944 to 1952.
- 1933** Fidel Castro led an unsuccessful attack on the Moncada Army Barracks in Santiago de Cuba.
- 1939** Castro's forces overthrew Batista's government, and Castro became ruler of the country.
- 1961** Cuban exiles invaded Cuba at the Bay of Pigs and were quickly defeated by Castro's army.
- 1962** The U.S.S.R. agreed to U.S. demands that it remove its missiles and missile bases from Cuba.
- 1976** Cuba adopted a new constitution. The constitution declared the nation to be a socialist state and a republic.
- 1991** The Soviet Union, which had been an important source of economic aid to Cuba, was dissolved.



Fulgencio Batista, famous for his fiery speechmaking, ruled Cuba as dictator from 1934 to 1944 and from 1952 to 1959.

tro organized the *26th of July Movement*, a revolutionary group named after the date of his first revolt. He then went to Mexico. Castro's forces landed in Cuba in December 1956. Most of the rebels were soon killed. However, Castro and 11 of his followers escaped to the Sierra Maestra mountains. In the mountains, they formed a guerrilla band to carry out surprise attacks against the Cuban government.

In 1957, Castro's forces began to attack army units and to blow up bridges and railway tracks. Attempts by the government to crush the revolution increased the people's support of the rebels. By mid-1958, Cubans had lost confidence in Batista's government. On Jan. 1, 1959, Batista fled the country. Castro's forces then took control of the government. Later, Castro became premier of Cuba. Manuel Urrutia was named president. The revolutionary leaders did away with the political and military structure of Batista's government. Many former political officials and army officers were tried and executed.

At first, the United States supported the Castro government. But the leading revolutionaries did not welcome U.S. support. In 1959 and 1960, the Cuban government nationalized American-owned sugar estates and cattle ranches, and relations declined sharply.

Immediately after the revolution, many Cubans who opposed Castro left the country. Most of them moved to the United States. In late 1959, a group of these exiles hired American planes and flew over Cuba, dropping anti-Castro leaflets and small fire bombs. Cuban leaders criticized the United States for not stopping the flights.

The Castro government grew more hostile toward the United States after Western European nations, under U.S. pressure, refused to sell arms to Cuba. Cuba then turned to the Soviet Union for economic and military assistance. The Soviet aid became substantial, and Cuba's economy depended on it heavily.

In June 1960, the Castro government took over American oil refineries in Cuba, after they refused to refine Soviet oil. The United States then stopped buying Cuban sugar. Castro responded by taking over all remaining U.S. businesses in Cuba. In January 1961, the United States ended diplomatic relations with Cuba.

The Bay of Pigs Invasion. In April 1961, Cuban exiles invaded Cuba at the Bay of Pigs on the south coast. President John F. Kennedy had approved the invasion, but he refused to send the military aid that he had promised. Castro's forces crushed the invasion and captured most of the exiles. His government later released many of the exiles to the United States in exchange for nonmilitary supplies.

The Cuban missile crisis. In 1962, Cuban leaders became convinced that the United States was planning an attack on Cuba. They asked the Soviet Union for more military aid. The Soviet Union responded by sending missiles and materials to build launch sites. In October, the United States learned that Cuba had missile bases that could launch nuclear attacks on American cities. U.S. President Kennedy ordered a naval blockade to halt the further shipment of arms and demanded that the Soviet Union remove all missiles and missile bases



Fidel Castro became the head of the Cuban government in 1959 after he and his supporters overthrew the dictatorship of Fulgencio Batista. Here Castro waves as he appears before a crowd of Cubans after he took power.

from the island. For several days, the world stood on the brink of nuclear war. Finally, the Soviet Union agreed to Kennedy's demands in return for a U.S. pledge not to attack Cuba. The Soviet Union removed the weapons under protest from Castro. But several thousand Soviet troops remained in Cuba.

Recent developments. The Cuban government objects to the presence of a United States naval base at Guantánamo Bay. But the United States refuses to give up the Guantánamo location. In 1964, Castro shut off the naval base's fresh-water supply. The United States then moved a plant that turns ocean water into fresh water to Guantánamo.

Castro has tried to spread revolution elsewhere in Latin America and has supplied military aid to guerrilla groups in several Latin-American countries. At first the guerrillas were not successful. Ché Guevara, a leader in the Castro revolution, was killed during a guerrilla operation in Bolivia in 1967. In the 1970's, Cuba trained and supplied weapons to members of the Sandinista National Liberation Front, then a guerrilla organization in Nicaragua. The Sandinistas won control of Nicaragua's government in 1979, and held power until 1990.

In the 1970's, Cuba became involved in a civil war in Africa. Cuban troops fought alongside a Marxist rebel group, also backed by the Soviet Union, which took over Angola's government in 1976. They were opposed by a guerrilla group supported by South Africa. Cuban troops remained in Angola to support the government. They began to withdraw in 1989, and had completely withdrawn by 1991. Cuba also aided Ethiopia in its war with Somalia in 1977 and 1978.

Relations between Cuba and the United States have remained strained since the early 1960's. But from time to time, there have been signs of improved relations between the two countries. For example, in 1977, the U.S. government ended its restrictions on travel to Cuba by American citizens. In 1982, however, the United States government reinstated severe travel restrictions to Cuba. Cuba and the United States also established diplomatic offices in each other's country in 1977. But the two nations did not resume full diplomatic relations.

Since the revolution, hundreds of thousands of Cubans have left the country because of their opposition to Castro or because of dissatisfaction with their social and economic conditions. Most of these people have settled in the United States. Others have settled in such Spanish-speaking countries as Mexico and Spain. An especially large emigration wave took place between April and September of 1980, when about 125,000 Cubans moved to the United States.

In the late 1980's, the Soviet Union and other European Communist countries began programmes to give their people more political and economic freedom. Castro criticized these reform efforts. Non-Communist governments replaced Communist governments in most of the Eastern European countries, including the Soviet Union in 1991. But Castro vowed that Cuba would remain a Communist country. Also in 1991, the Soviet government announced it would remove its troops from Cuba, and by 1993, all troops from the former Soviet Union had been removed.

When the Soviet Union was dissolved in December 1991, Cuba lost its most important trading partner and source of aid. Exports fell from U.S. \$8.1 billion in 1989 to U.S. \$1.7 billion in 1991 and the economy was thrown into crisis. The government introduced strict rationing of food and other essentials, such as soap and fuel. It claimed that severe food shortages were mainly a result of the continuing blockade by the United States. In 1993, Cuba made the U.S. dollar a legal currency. This led to a sharp decline in the value of the peso and an increase in black market trading.

In 1994, large numbers of Cubans attempted to emigrate, many in dangerously overcrowded boats. In May, more than 100 asylum-seekers occupied the Belgian embassy in Havana. Street protests against the government erupted in August. This prompted Fidel Castro to threaten to allow a flood of Cuban refugees to emigrate to the United States if the U.S. continued to encourage them. The U.S. government then announced that it would no longer allow Cubans to enter the country. However, Cuba and the U.S. finally reached a deal in September 1994. Cuba agreed to take measures to slow the flood of refugees. In turn, the U.S. promised to accept 20,000 legal Cuban immigrants each year.

Related articles in *World Book* include:

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Guantánamo	Havana	Santiago de Cuba
History		
Batista y Zaldivar, Fulgencio		Guevara, Ché
Castro, Fidel		Kennedy, John F. (Kennedy's administration 1961-1963)
Columbus, Christopher		Martí, José Julian
García y Iñiguez, Calixto		Spanish-American War
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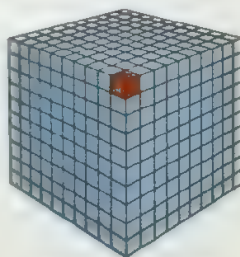
E. Fishing
F. Trade
G. Transportation and communication

VI. History

Questions

What was the Platt Amendment?
What are the two major goals of Cuba's government?
What are Cuba's two most important crops?
What was the 26th of July Movement?
How has Cuba promoted adult education?
What are *state farms*?
What was the Cuban missile crisis?
Why does Cuba have a mild climate all the year round?
What is *Santería*?
Why has Cuba's economy developed slowly under Fidel Castro?

Cube, in geometry, is a solid bounded by six equal squares, such as a child's alphabetical block. All the edges that make up the length, width, and depth of a cube are equal to each other. The *volume* of a cube, or the space it fills, is expressed in cubic metres, cubic centimetres, or some other cubic unit. The volume is found by multiplying the number that represents the length of one of the edges by itself, then multiplying by the length again. For example, if the edge of a cube is 4 metres, the volume of the cube is $4 \times 4 \times 4$, or 64 cubic metres.



A cube is bounded by six equal squares. Each face of a cube of one cubic metre is 1 metre, or 10 decimetres, long and 10 decimetres wide. The volume is $10 \times 10 \times 10$, or 1,000 cubic decimetres. The small red cube is $\frac{1}{1000}$ of the length, breadth, and depth.

In arithmetic, the *cube* of a number is the product obtained when a number is used as a factor three times. Thus, the cube of 4 is $4 \times 4 \times 4$, or 64. This can be indicated by 4^3 . See also **Cube root**; **Root**.

Cube root is one of three equal factors of a number (see **Factor**). The same number (m) taken as a factor three times will be the cube root of another number (n). Thus, $m \times m \times m = n$. For example, 2 is the cube root of 8, because $2 \times 2 \times 2 = 8$, and -5 is the cube root of -125 , because $-5 \times -5 \times -5 = -125$. A real number has only one real cube root, which is positive or negative, according to whether the given number is positive or negative. Another symbol is placed in front of a number to indicate that its root is to be *extracted*, or determined. This symbol is written $\sqrt{}$, and is called the *root sign*, or *radical sign*. If the root to be extracted is a cube root, a small figure 3 is placed above the root sign. Thus, $\sqrt[3]{8}$ indicates that the cube root of 8 is to be determined.

Finding cube roots by tables. Perhaps the easiest way of finding cube roots is to use a *table of cube roots*, a *table of cubes*, or a *table of logarithms*. These tables provide correct answers and eliminate tedious calculations. In most cases, the numbers will not have exact cube roots. In these cases, tables are especially helpful.

Calculating cube roots. Sometimes tables may not be available. Or, if they are, they will not be accurate enough for a particular purpose. In this case, a person must make his or her own calculations.

One procedure, called *Newton's method*, is easy to use with a calculator. It can be used to calculate the cube root of a number between 1 and 1,000. For example, a person might wish to find the cube root of 200. Since $5 \times 5 \times 5 = 125$, and $6 \times 6 \times 6 = 216$, it is easy to see that 6 is the closest *integral*, or whole number, cube root of 200. A closer complete approximation can be made by dividing 200 by the square of 6, or 6×6 , which equals 36. To the nearest tenth, this gives 5.6. Thus, $6 \times 6 \times 5.6$ is approximately 200.

To get the second approximation of the cube root of 200, average the three factors 6, 6, and 5.6. This will give $\frac{6+6+5.6}{3} = 5.9$. This procedure is repeated to obtain a still better approximation. Thus,

$\frac{200}{5.9 \times 5.9} = \frac{200}{34.81} = 5.74$, and the next approximation is given by $\frac{5.9+5.9+5.74}{3} = 5.85$. Repeating once more

gives $\frac{200}{5.85 \times 5.85} = \frac{200}{34.2225} = 5.8441$, which gives the next approximation $\frac{5.85+5.85+5.8441}{3} = 5.8480$.

This process may be continued indefinitely. In each approximation beyond the second, you can retain a number of digits that is one less than twice the number of digits found in the previous approximation. For example, the second approximation, 5.9, contains two digits. The third approximation may retain three digits, and the fourth approximation may retain five digits.

If the number whose cube is desired is not between 1 and 1,000, either multiply or divide it successively by 1,000 to bring it within this range. The cube root of this number will lie between 1 and 10. After finding the cube root, either divide or multiply it successively by 10 as many times as necessary to give the cube root of the original number.

See also **Cube**; **Logarithms**; **Root**.

Cubic measure. See **Weights and measures**.

Cubism was the most influential movement in the history of modern art. The cubists introduced radically new approaches to portraying form and space. They revolutionized painting and other arts during the 1900's.

Cubism began in France and flourished as a movement from 1907 to 1914. Its leaders were the Spanish artist Pablo Picasso and the French artist Georges Braque. Other cubists included Juan Gris of Spain and Robert Delaunay and Fernand Léger of France. The cubist painters shunned conventional treatment of space and form. A typical early cubist painting analyses the subject matter in basic geometric shapes and elementary signs. By reorganizing and overlapping these elements, the cubists often tried to show the subject from several viewpoints at the same time.

Many cubist paintings are still lifes that portray such commonplace objects as tabletops, musical instruments, and bottles. Many painters of the cubism movement were inspired by everyday subject matter, such as advertisements, cartoons, and popular songs. Artists often painted numbers and words in their pictures. The cubists also made *collages*, which combine painting with real objects, such as newspaper cuttings or oil-cloth. In addition, the cubists were strongly influenced by the geometric simplicity and expressive power of black African sculpture.

There are two kinds of cubist painting—*analytic cubism* and *synthetic cubism*. Analytic cubism emerged about 1910. It took its name from the way artists broke down, or *analysed*, and then reassembled observed forms in various ways. Synthetic cubism, which began about 1912, tried to *synthesize* (combine) imaginative elements into new figurative forms.

Picasso's *Les Femmes d'Alger* (1907) is the first important cubist painting. Braque painted a series of landscapes in the town of l'Estaque, near Marseille, France, that had a strong geometric character. Art critic Louis Vauxcelles saw the paintings in 1908 and used the term "cubes" to describe them, thus naming the movement.

For other examples of cubist painting, see **Painting (Cubism)**; Duchamp, Marcel; Léger, Fernand. See also Braque, Georges; Cézanne, Paul; Gris, Juan; Picasso, Pablo

Cubit is a measure of length used by several early civilizations. It was based on the length of the forearm from the tip of the middle finger to the elbow. No one knows

when this measure was established. The length of the arm, or cubit, was used by many early peoples, including the Babylonians, Egyptians, and Hebrews.

The royal cubit of the ancient Egyptians was about 51 centimetres long. That of the ancient Romans was 44.5 centimetres. The Hebrew cubit was 44.7 centimetres. In the English system the cubit is 46 centimetres. See also **Measurement (length and distance)**.

Cuchulainn, also spelled Cuchulain, is a great hero of Irish mythology and folklore. He is the main character in *The Cattle Raid of Cooley*, the oldest epic of western Europe in a native language. It is the central story of the Ulster cycle of ancient Irish tales. Said to have taken place about the time of Jesus Christ, the story has a slim base in fact, but the details are mythological. Cuchulainn's reputation as a warrior grew in Irish folk tales until he came to be treated as a defender of all Ireland. Cuchulainn became a favourite character among writers of the Irish Literary Renaissance, a period of artistic attention to sources within the Irish tradition that began in the late 1800s.

Cuchulainn had extraordinary powers because his father was *Lugh (lool)*, an important Celtic god. He won the name Cuchulainn (Hound of Culan) by offering to take the place of a ferocious watchdog he had killed at the house of Culan.

See **Irish Literature** (Heroic tales, romances, and sagas); **Mythology** (The Irish cycles).



Museum of Modern Art, New York

Early cubism grew from Pablo Picasso's *Les Femmes d'Alger*, of 1907, above. Black African sculpture influenced it.



The Bottle of Barnols (1914), a gouache and pencil with paper collage on canvas by Juan Gris, Kunstmuseum, Bern, Switzerland

Synthetic cubism flourished in 1913 and 1914. It was more realistic and colourful than the earlier analytic cubist style.



Museum of Modern Art, New York

Analytic cubism divided objects into many fragments and planes, as in Georges Braque's *Man with a Guitar* of 1911, above.



The black-billed cuckoo has a long, slightly curved black beak and red circles around its eyes. This species is found in North America east of the Rocky Mountains.

Cuckoo is any one of a group of related birds found throughout most of the world. The name *cuckoo* comes from the song of the *Old World common cuckoo*. This song also serves as the basis for the well-known sound of the cuckoo clock. Cuckoos have rather long and slightly curved beaks. They differ from most birds because two of their toes point forward and two backward. In most species of birds, three toes point forward and one toe points backward. Cuckoos tend to feed on caterpillars, including those with poisonous hairs that are not eaten by other birds.

The Old World common cuckoo is about 30 centimetres long. Males and females both have white breasts with dark bars. The head and back of the males are grey, but those of the females are grey or brown. The Old

World common cuckoo is found throughout Europe and most of Asia, and in Africa south of the Sahara.

The common cuckoo, like many other Old World species of cuckoos, does not care for its own young. It lays its eggs in another bird's nest and leaves them to be hatched and cared for by the other bird. The common cuckoo will lay its eggs in the nest of a particular species of songbird; reed warblers and hedge sparrows are common host birds. The cuckoo's egg often matches the colour of the host bird's egg but is much larger.

The cuckoo's egg develops very rapidly and is usually the first to hatch. The newly hatched cuckoo moves about in the nest until the hollow in its back comes into contact with another egg or young chick. The cuckoo then climbs up the side of the nest using its strong legs, and ejects the other eggs and chicks from the nest. The cuckoo repeats this move until all other eggs and chicks are removed from the nest, leaving the cuckoo chick to receive all the food brought to the nest by its foster parents.

In some cases, such as the *great spotted cuckoo* of southern Europe, and the Australian *koel* or *cooee* bird, the young cuckoo shares the nest with the young of the host species. The cuckoo grows more rapidly than the other chicks. It either tramples the other chicks to death or receives most of the food brought to the nest, causing the other chicks to die of starvation.

Cuckoos are common birds in Australia. Australia has 14 kinds of cuckoos, 13 of which, like the Old World common cuckoo, lay their eggs in other birds' nests. One of the commonest species in southern Australia is the *pallid cuckoo*, whose call consists of a series of notes on a rising scale. The koel is found in northern and eastern Australia.

Two common kinds of cuckoos that live in North America are the black-billed cuckoo and the yellow-billed cuckoo. Their songs consist of a series of low, mournful, quivering notes. Both of these cuckoos are slender birds about the same size as the Old World common cuckoo. They have long, rounded tails, olive-



The common cuckoo of the Old World lays its eggs in the nest of another bird. The cuckoo chick then pushes all eggs laid by its foster parent out of the nest. The photo on the left shows a young cuckoo being fed by its foster parent, a woodchat shrike. The young bird is already much larger than its foster parent.

brown backs, and white breasts. They differ chiefly in the colour of the bill. In addition, the black-billed cuckoo has a red circle around its eyes, and the yellow-billed cuckoo has larger white marks on its tail.

Black-billed and yellow-billed cuckoos make their homes in woods, thickets, and orchards. They build untidy nests. There may be two to seven eggs in one nest. The eggs are green-blue with a dull surface. These cuckoos migrate to the tropics for the winter.

Scientific classification. Cuckoos belong to the cuckoo family, Cuculidae. The Old World common cuckoo is *Cuculus canorus*. The great spotted cuckoo is *Clamator glandarius*. The Australian koel is *Eudynamis scolopacea*. The pallid cuckoo is *Cuculus pallidus*. The black-billed cuckoo is *Coccyzus erythrophthalmus*, and the yellow-billed cuckoo is *Coccyzus americanus*.

See also Ani; Roadrunner.

Cuckoo-shrike is the name of a family of about 70 species of songbirds. Cuckoo-shrikes live in Africa, Asia, Australia, and the Pacific Islands. They are not related to either shrikes or cuckoos. But they have notched bills like those of shrikes, and some have barred feathers like those of many cuckoos.

Cuckoo-shrikes range from 15 to 32 centimetres in length. They have a thick cluster of stiff feathers on their rumps. These feathers fall out easily and so help protect cuckoo-shrikes from hawks and other birds that prey on them. A hawk that strikes a cuckoo-shrike on the rump may catch only a mass of feathers instead of the bird itself.

Most cuckoo-shrikes have long wings and tails. The majority of species are varying shades of grey or black, and white. However, some African cuckoo-shrikes have bright areas of yellow, orange, or red. Males of most kinds of minivets—a group of cuckoo-shrike species found in Asia—are black, and bright red or orange.

Most cuckoo-shrikes live in tropical woodlands. They eat caterpillars and other insects, and fruit. Flocks of cuckoo-shrikes continually fly from one tree to another in search of food. However, the ground cuckoo-shrike,



A cuckoo-shrike has a notched bill. Most species have long wings and tails, and feathers that are white and black or grey. The ground cuckoo-shrike, above, lives in Australia.



Cucumbers grow on vines that have many coiled growths called tendrils. The plant has triangular leaves and yellow or whitish flowers. Cucumbers are eaten raw or pickled.

which lives in the dry interior of Australia, searches for food on the ground.

Cuckoo-shrikes build cup-shaped nests in trees, and, in most cases, lay from two to three eggs. The eggs of most species are greenish, with brown, grey, or violet spots or blotches.

Scientific classification. Cuckoo-shrikes make up the family Campephagidae. The ground cuckoo-shrike is *Pteropodops maxima*.

Cuckoo-pint. See Arum.

Cucumber is a common garden vegetable native to southern Asia, but cultivated as an annual in many parts of the world. The cucumber plant is a hairy-stemmed vine that bears many tendrils. Its triangular leaves may have three pointed lobes. The plant bears yellow or whitish flowers on short stems. Its edible fruit, which is commonly called cucumber, may grow from 25 to 90 centimetres long. The pulpy fruit generally contains many seeds, though some types are seedless. It is covered by a thin, smooth or prickly skin. The flesh of the fruit is usually white or yellowish.

Small cucumbers used for pickling are often called gherkins. But the true gherkin is another plant closely related to the cucumber. It bears many little spiny fruits shaped like olives.

People eat the young cucumber fruits raw or pickle them. The raw fruits are eaten in salads and sandwiches. The mature fruits are tough and contain many hard seeds. They are sometimes pickled or served as a hot vegetable. Cucumbers are a good low-calorie salad item. They are also a good source of iron and calcium, and they provide a moderate amount of vitamins.

Cucumbers grow best in warm weather and are easily killed by frost. Gardeners grow them from seed. They sow the seed in small hills of loam or light soil as soon as warm weather comes. They form the hills about 1.2 metres apart to allow room for the vines to grow. When the plants start to grow, they are thinned so only four or

five remain in a hill. The plants grow rapidly in warm weather and if they have enough moisture. Small fruits suitable for pickles appear quite soon. Gardeners pick them every two or three days.

Some cucumbers, particularly the seedless type, are grown in greenhouses. The plants grow much as they do in fields. But usually, because of the limited space, the gardener trains the vines on cords or wires. A cucumber plant frequently yields 100 or more fruits.

A number of pests attack cucumbers. *Mosaic* is a virus disease spread by the *melon aphid*. In an infected cucumber plant, the leaves become mottled with yellow and the fruit is light yellow-green in colour.

Scientific classification. The cucumber belongs to the gourd family, Cucurbitaceae. It is *Cucumis sativus*. Gherkins are *C. anguria*.

Cud is a small mass of food that animals called *ruminants* bring up from their stomachs for a second chewing. Ruminants include antelopes, camels, cattle, deer, and goats. See also **Ruminant**; **Cattle** (Stomach).

Cuenca (pop. 152,406) is a city in the Andes Mountains of southern Ecuador. For Cuenca's location, see Ecuador (political map). Cuenca, a commercial centre, leads Ecuador in the production of Panama hats. Other important products include cinchona bark, which is used to make drugs; gold; hides of alligators and other animals; and tyres. The city has a modern cathedral and a picturesque market where Indians of the region sell their goods. Spaniards founded Cuenca in 1557.

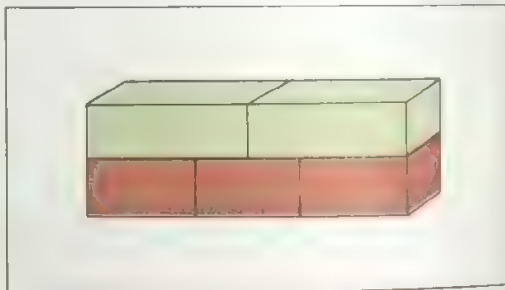
Cuillin Hills are a range of mountains on the Isle of Skye, in Highland Region, Scotland. Some people call them the *Coolins* or *Cuchullins*. The main ridge is called the *Black Coolins*. It is 10 kilometres long and curves round Loch Coruisk. The tallest peak is Sgurr Alasdair, which rises to a height of 1,009 metres above sea level. Another part of the range, called the *Red Coolins*, includes Glamaig, which rises to a height of 773 metres. The Cuillins are the steepest hills in Britain. See also **Highland Region**; **Skye** and **Lochalsh**.

Cuisenaire Method is a teaching system designed to help students discover basic mathematical principles by themselves. The method uses rods of ten different colours and lengths that are easy to handle. By using the rods, students can prove numerical relationships and understand principles of proportion. They can also use the rods in learning addition, subtraction, multiplication, division, factoring, and fractions.

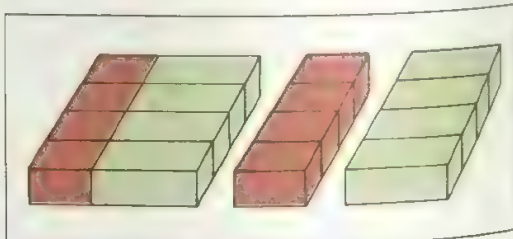
The rods help the student understand mathematical principles rather than merely memorize them. For example, two white rods placed end to end are the same length as a red rod. The red rod then stands for the number 2 if the white rod represents 1. A red rod and a white rod placed end to end are as long as a light-green rod. The light-green rod then stands for 3, because it is as long as three white rods. The rods can also be used to represent different sets of numbers. For example, if the white rod is assigned a value of 3, the red rod becomes 6.

Students can discover many facts about mathematical relationships by working with the rods. For example, three red rods placed end to end are as long as one dark-green rod. The dark-green rod is two-thirds as long as a blue rod. Students can see that the three red rods equal two-thirds of a blue rod.

The rods also can be used to teach such elementary arithmetic properties as the associative, commutative, and distributive properties. For instance, to help students understand that $3 \times 2 = 2 \times 3$, an example of the commutative property, two light-green rods can be placed on top of three red rods, as shown below.



To show that $4 \times (2 + 3) = (4 \times 2) + (4 \times 3)$, an example of the distributive property, a set of four red rods and four light-green rods can be split into two sets. One of the two sets would have four red rods. The other would have four light-green rods. See the illustration below.



Schoolteachers use the Cuisenaire Method as one of a number of systems for teaching mathematics. Emile-Georges Cuisenaire, a schoolteacher from Thuin, Belgium, developed the method.

Cukor, George (1899-1983), was an American film director. He became noted for his ability to draw superior performances from some of Hollywood's leading actresses. Cukor directed Greta Garbo in *Camille* (1937), Katharine Hepburn in *The Philadelphia Story* (1940), Judy Holliday in *Born Yesterday* (1950), and Judy Garland in *A Star Is Born* (1954). He won an Academy Award for directing *My Fair Lady* (1964). Cukor directed more than 40 films.

Cukor was born in New York City. He directed plays on Broadway before going to Hollywood in 1929. The first film he directed was *Tarnished Lady* (1931). During the 1930's, he made several films based on literary classics, including *Little Women* (1933) and *David Copperfield* (1935).

Cukor also directed the popular comedies *Adam's Rib* (1949) and *Pat and Mike* (1952), both of which co-starred Katharine Hepburn and Spencer Tracy. Cukor's other films include *A Bill of Divorcement* (1932), *Holiday* (1938), *The Women* (1939), and *Travels with My Aunt* (1972).

Culebra Cut. See Panama Canal (The Gaillard Cut).

Culex. See Mosquito (pictures).

Cullinan Stone. See Diamond (Famous diamonds; picture).

Cullen, Paul Cardinal (1803-1878) Roman Catholic Archbishop of Dublin, was active in reforming the Irish educational system to provide better education for Roman Catholics. He called for separation of church and secular schools and, in 1851, founded the Catholic University of Ireland, the first Roman Catholic university in the country. He worked for reform but instructed his priests not to become involved in political matters. He supported the doctrine of papal infallibility at the Vatican Council in 1870. Cullen was born at Prospect, in County Kildare. He became Archbishop of Dublin in 1852 and was made a cardinal in 1866.

Culloden is a moor in Highland Region, Scotland. It is famous for the battle fought there in 1746, when the Scots, under Prince Charles Edward Stuart, were defeated by the English, led by the Duke of Cumberland. A stone cairn marks the site of the battle. Nearby are the Graves of the Clans and the Well of the Dead. The Stones of Clava are nearby, on the other side of the River Nairn. These stones, erected during the Bronze Age, are among the most important ancient remains in Scotland. Culloden is about 8 kilometres east of Inverness. See also Highland Region.

Cult is a religious group devoted to a living leader, a new teaching, or an unusual practice. Cults range in size from a few followers living under the command of their leader to worldwide organizations directed by a complex chain of command. Such groups rarely call themselves cults and generally reject the term. Most historians of religion use the more neutral term *new religious movement* instead of *cult*.

Because there is no one definition of cults, their number and membership cannot be accurately measured. However, experts have estimated that about 3,000 cults exist throughout the world. Together, these cults claim a membership of about 3 million persons, most of whom are young adults.

Characteristics of cults. Traditionally, the term *cult* referred to any form of worship or ritual observance, or even to any group of people pursuing common goals. But publicity about cults since the middle 1900's has given the term a more specific meaning. Today, it usually refers to a group following a living leader who promotes new and *occult* (strange and mysterious) doctrines and practices.

Most cult leaders demand that members live apart from everyday society in groups called *communes*. Cult leaders claim that they possess exclusive religious truth, and they command absolute obedience and allegiance from the people who belong to the cult. Many cults require that members contribute all their possessions to the group.

Modern cults. Probably the most notorious U.S. cult of the late 1900's was the People's Temple, a group led by Jim Jones, a Protestant clergyman. Hundreds of cult members moved into a rural commune called Jonestown in the South American country of Guyana. There they lived under Jones's absolute rule. In 1978, cult leaders murdered a United States congressman and three journalists investigating activities in Jonestown. Jones

then ordered his followers to commit suicide. Jones's order resulted in the deaths of over 900 people. See Guyana (History).

Two of the largest cults in Western countries began in Asia. The International Society for Krishna Consciousness, commonly called Hare Krishna, was organized in Calcutta, India, in 1954. During the 1960's and 1970's, the cult established many centres in Western cities. Members of Hare Krishna ask for money in airports and other public places. The men shave their heads, and members meditate in strictly regulated communes.

The other Asian cult, the Unification Church, is ruled by its Korean founder, the evangelist Sun Myung Moon. The cult is an adaptation of Christianity. Its members are commonly called "Moonies." They believe that by converting people to their religion, they will bring about a final showdown between the forces of good and the forces of evil represented by international Communism. Leaders justify enforcing religious and political uniformity on their followers because they believe right is entirely on their side.

Less aggressive and more loosely organized cults tend to stress personal, individual meditation. Transcendental Meditation and Zendo are examples of such meditation. See Transcendental Meditation.

History. Throughout history, many religious groups have been classified as cults. Christianity began as a cult within Judaism and developed into an established church. In modern times, groups that began as cults and developed into organized churches include the Quakers, Mormons, Rastafarians, Swedenborgians, Christian Scientists, Methodists, Jehovah's Witnesses, and Seventh day Adventists. Countless other cults were either absorbed into existing religious movements or faded away. The Amish, members of a North American Protestant group who trace their history back to the 1500's, are an example of a cult that has changed very little over the centuries.

See also Mysteries.

Cultivation system. See Cropping system.

Cultivator. See Agriculture. Pest control (pictures).

Cultural anthropology. See Anthropology.

Cultural lag is the failure of certain parts of a culture to keep up with other related parts. William F. Ogburn, an American sociologist, introduced the term in the 1920's. He noted that the development of technology caused rapid changes in *material culture*, including housing, machinery, and industrial processes. But he observed that *nonmaterial culture*, including ideas, values, and social systems, often lagged behind material culture.

According to Ogburn, many social problems result from cultural lag. For example, new inventions may replace many workers. The time it takes these workers to learn new skills and find other jobs is a cultural lag that results in unemployment.

Today, social scientists realize that changes in ideas and social systems may sometimes occur before changes in technology. They refer to the condition that results when related parts of a culture change at different rates as *cultural dissonance*.

See also Culture (How culture changes).

Cultural Revolution. See China (The Cultural Revolution).



Different cultures have different customs. A bride and groom in Poland, *left*, kneel as a priest says Mass. Among the Dorze in Ethiopia, *centre*, the groom's friends pretend to kidnap the bride. At a Hindu wedding in Singapore, *right*, a priest sprinkles the couple with holy water.

Culture

Culture is a term used by social scientists for a way of life. Every human society has a culture. Culture includes a society's arts, beliefs, customs, institutions, inventions, language, technology, and values. A culture produces similar behaviour and thought among most people in a particular society. To learn about a culture, one may ask such questions as these: What language do the people speak? What do the people of the society wear? How do they prepare their food? What kind of dwellings do they live in? What kind of work do they do? How do they govern themselves? How do they judge right from wrong?

People are not born with any knowledge of a culture. They generally learn a culture by growing up in a particular society. They learn mainly through the use of language, especially by talking and listening to other members of the society. They also learn by watching and imitating various behaviours in the society. The process by which people—especially children—learn their society's culture is called *enculturation*. Through enculturation, a culture is shared with members of a society and passed from one generation to the next. Enculturation unifies people of a society by providing them with common experiences.

The term *culture* has been defined in many ways. It is often used in a narrow sense to refer to activities in such fields as art, literature, and music. In that sense, a *cultured person* is someone who has knowledge of and appreciation for the fine arts. But under the broader definition used by social scientists, culture includes all areas

of life, and all human beings have a culture.

Social scientists identify certain aspects of culture as *pop culture* or *popular culture*. Pop culture includes such elements of a society's arts and entertainment as television, radio, recordings, advertising, sports, hobbies, fads, and fashions.

The term *civilization* is similar to culture, but it refers mostly to cultures that have complex economic, governmental, and social systems. A civilization is technologically more advanced than other cultures of its time. A culture is any way of life, be it simple or complex, advanced or not advanced.

For hundreds of thousands of years, human beings have had at least some of the biological abilities on which culture depends. These abilities are to learn, to use language and other symbols, and to employ tools to organize their lives and adapt to their environments. Besides human beings, other animals also have such elements of culture as the ability to make and use tools and the ability to communicate. For example, elephants break off tree branches and wave them with their trunks to brush off flies. Dolphins communicate with one another by means of barks, whistles, and other sounds. But no other animals have developed language and other symbols as complex as those of human beings. Thus no other animal possesses to the same extent the abilities to learn to communicate, and to store, process, and use information. The rest of this article focuses on the main aspects of human culture.

Characteristics of culture

There are several important characteristics of culture. The main ones are these: (1) A culture satisfies human

needs in particular ways. (2) A culture is acquired through learning. (3) A culture is based on the use of symbols. (4) A culture consists of individual *traits* and groups of traits called *patterns*.

Satisfying basic needs. All cultures serve to meet the basic needs shared by human beings. For example, every culture has methods of obtaining food and shelter. Every culture also has family relationships, economic and governmental systems, religious practices, and forms of artistic expression.

Each culture shapes the way its members satisfy human needs. Human beings have to eat, but their culture teaches them what, when, and how to eat. For example, many British people eat smoked fish for breakfast, but many Americans prefer cold cereals. In the Midwestern United States, people generally eat dinner at 5 or 6 p.m. However, most Spaniards dine at 10 p.m. Many Turks prefer strong coffee with the grounds left in the cup, but most Australians filter out the grounds for a weaker brew. Many Japanese eat their meals from low tables while sitting on mats on the floor. Canadians usually sit on chairs at higher tables.

Learning. Culture is acquired through learning, not through biological inheritance. That is, no person is born with a culture. Children take on the culture in which they are raised through enculturation.

Children learn much of their culture through imitation and experience. They also acquire culture through observation, watching what goes on around them and seeing examples of what their society considers right and wrong. Children may also absorb certain aspects of culture unconsciously. For example, Arabs tend to stand closer together when speaking to one another than most Europeans do. No one instructs them to do so, but they learn the behaviour as part of their culture.

Children also learn their culture by being told what to do. For example, a parent tells a son or daughter, "Say thank you" or "Don't talk to strangers." Individual members of a particular culture also share many memories, beliefs, values, expectations, and ways of thinking. In fact, most cultural learning results from verbal communication. Culture is passed from generation to generation chiefly through language.

Using symbols. Cultural learning is based on the ability to use symbols. A symbol is something that stands for something else. The most important types of symbols are the words of a language. There is no obvious or necessary connection between a symbol and what it stands for. The English word *dog* is a symbol for a specific animal that barks. But other cultures have a different word that stands for the same animal—the French word *chien*, for example, or the Swahili word *mbwa*.

There are many other kinds of symbols besides the words in a language. A flag, for example, stands for a country. Colours have symbolic meaning, and the meanings vary from culture to culture. For Chinese people, white is a colour of mourning. In Western societies, black is the colour of mourning. White is a symbol of purity, and brides wear white. All human societies use symbols to create and maintain culture.

Forming patterns. Cultures are made up of individual elements called *cultural traits*. A group of related traits is a *cultural pattern*.

Cultural traits may be divided into *material culture* and *nonmaterial culture*. Material culture consists of all the things that are made by the members of a society. It includes such objects as buildings, jewellery, machines, and paintings. Nonmaterial culture refers to a society's behaviours and beliefs. A handshake, a marriage ceremony, and a system of justice are examples of nonmaterial culture.

Cultural patterns may include numerous traits, both material and nonmaterial. The pattern for agriculture, for example, includes the time when crops are harvested (nonmaterial), the methods (nonmaterial) and machinery (material) used in harvesting, and the structures for storing the crops (material).

Most traits that make up a cultural pattern are connected to one another. If one custom, institution, or value that helps form a cultural pattern changes, other parts of the pattern will probably change, too. For example, until the 1950's, the career pattern for most women in Western societies was to work full-time as homemakers and mothers. By the late 1900's, the pattern was for most women to have jobs outside the home. As part of the new pattern, attitudes about marriage, family, and children also changed. The new pattern includes marriage at a later age, a dependence on alternative child-care systems, and more frequent divorce.

The boundaries of cultures

Every human society has a culture. People who grow up in the same nation can be said to share a *national culture*. But they may be part of other societies within the nation that have separate cultural traditions.

Social scientists sometimes use the term *subculture* to describe variations within a culture. Social groups often develop some cultural patterns of their own that set them apart from the larger society they are part of.



The way people greet each other is one example of the way customs differ from culture to culture. Two Asians, above, greet each other with a bow.

Subcultures may develop in businesses, ethnic groups, occupational groups, regional groups, religious groups, and other groups within a larger culture. For example, Amish people in Pennsylvania, U.S.A., make up a subculture, as do members of a teen-age street gang in an Asian city.

Many cultural traits and patterns are limited to a particular culture, but many others are common to more than one culture. For example, cultures in the same part of the world often have similar patterns. A geographical region in which two or more cultures share cultural traits and patterns is called a *culture area*. Northern Europe is an example of a culture area.

Some cultural traits have spread throughout the world. For example, some clothing, music, sports, and industrial processes are the same in many areas of the world. Cultural traditions that extend beyond national boundaries form what is called *international culture*. For example, countries that share an international culture include Australia, Canada, the United Kingdom, and the United States. Their common cultural traditions include the English language and a heritage of British founders.

Culture and society

Multiculturalism. Some societies—such as those of Tibetans in Tibet and various peoples of the Pacific Islands—have traditionally been associated with a single culture. Other societies—such as those of the United States and Canada—are multicultural societies. They include many distinct cultures.

A shared cultural background makes people feel more comfortable with other people from their own culture. Many people initially may feel confused and uneasy when they deal with people of another culture. The discomfort that people often feel when they have contact with an unfamiliar culture is called *culture shock*. Culture shock usually passes if a person stays in a new culture long enough to understand it and get used to its ways.

People of one culture who move to a country where another culture dominates may give up their old ways

and become part of the dominant culture. The process by which they do this is called *assimilation*. Through assimilation, a minority group eventually disappears because its members lose the cultural characteristics that set them apart. In a multicultural society, however, assimilation does not always occur.

A multicultural society supports the view that many distinct cultures are good and desirable. The multicultural view encourages such diversity. Thus, in the United States, millions of people speak both English and the language of their own culture. They eat both American food (apple pie and hamburgers) and ethnic food. They celebrate both national holidays (Fourth of July and Thanksgiving) and their ethnic holidays. For example, many Mexican Americans celebrate Mexican Independence Day on September 16. In Chinese communities across the country, parades and other festivities mark the Chinese New Year.

Multiculturalism succeeds best in a society that has many different ethnic groups and a political system that promotes freedom of expression and awareness and understanding of cultural differences. Ethnic groups can bring variety and richness to a society by introducing their own ideas and customs. However, ethnic groups that keep their own values and traditions can also threaten national unity. In many parts of the world, neighbouring ethnic groups dislike and distrust one another. In some cases, these feelings have even led to war. In Bosnia-Herzegovina, for example, a civil war broke out in the early 1990's between Serbs and non-Serbs, who included Bosnian Muslims and Croats.

Ethnocentrism and cultural relativism. Many people in all cultures think that their own culture is right, proper, and moral. They tend to use their own cultural standards and values to judge the behaviour and beliefs of people from different cultures. They regard the behaviour and beliefs of people from other cultures as strange or savage.

The attitude that one's culture is best is called *ethnocentrism*. Ethnocentrism is harmful if carried to extremes. It may cause prejudice, automatic rejection of



Football (also called soccer), the world's most popular sport, is played by millions of people from many different cultures. Some cultural traits are common to one or a few cultures, but others—like football—have spread beyond such boundaries and have become part of what is called *international culture*.

ideas from other cultures, and even persecution of other groups.

The opposite view of ethnocentrism is called *cultural relativism*. It contends that no culture should be judged by the standards of another culture. This view can also present problems if carried to extremes. An extreme cultural relativist would say there is no such thing as a universal morality. An extreme cultural relativist would argue that the rules of all cultures deserve equal respect, even rules that allow such practices as cannibalism and torture. However, many social scientists would reply that certain values are common to all societies—a prohibition against incest, for example, and support for marriage. Such social scientists would argue that international standards of justice and morality should not be ignored.

How cultures change

Every culture changes. But all parts of a culture do not change at the same time. For example, science and technology may sometimes change so rapidly that they lessen the importance of customs, ideas, and other non-material parts of a culture. At other times, changes in ideas and social systems may occur before changes in technology. The failure of certain parts of a culture to keep up with other, related parts is referred to as *cultural lag*.

A number of factors may cause a culture to change. The two main ones are (1) contact with other cultures and (2) invention.

Contact with other cultures. No society is so isolated that it does not come in contact with other societies. When contact occurs, societies borrow cultural traits from one another. As a result, cultural traits and patterns tend to spread from the society in which they originated. This spreading process is called *diffusion*. The cultivation of maize, for example, began in what is now Mexico thousands of years ago and eventually spread throughout the world.

Diffusion can occur without firsthand contact between cultures. Products or patterns may move from group A to group C through group B without any contact between group A and group C. Today, diffusion is rapid and widespread because many cultures of the world are linked through advanced means of transportation and communication.

When two cultures have continuous, firsthand contact with each other, the exchange of cultural traits is called *acculturation*. Acculturation has often occurred when one culture has colonized or conquered another, or as a result of trade. In addition to adopting each other's traits, the two cultures may blend traits. For example, if the people of the cultures speak different languages, they may develop a mixed language called *pidgin* in order to communicate. The cultures may also exchange or blend such traits as clothing, dances, music, recipes, and tools.

Through acculturation, parts of the culture of one or both groups change, but the groups still remain distinct. In this way, acculturation differs from assimilation. Through the process of assimilation, one group becomes part of another group and as a result, loses its separate identity.

Invention is the creation of a new device, process, or



Cultures change through contact with one another. For example, Hong Kong blends Eastern and Western ways of life. This fast-food restaurant in Hong Kong sells American-style ham burgers and soft drinks.

product. Inventions provide a new solution to an old or new problem. Without inventions, human beings would be at the mercy of the climate and the land. Inventions have given people much control over their environment and enabled them to lead easier lives.

Inventions have led to many changes in a culture. The invention of agriculture, for example, made it possible for people to settle in farm villages. Their values and social organization changed. They placed importance on using land and animals to produce crops. They began to build permanent housing. They developed systems of irrigation and a number of tools.

The invention of spinning and weaving machines and an improved steam engine in the 1700's produced another great change in the way people lived. These inventions led to the opening of factories. Many people who had worked at home in rural areas flocked to the cities to work in the new factories. As cities became more crowded, new kinds of political, economic, and social systems developed.

The invention of the electronic computer in the mid-1900's has had an enormous impact. Computers have brought far-reaching changes in communication, education, entertainment, and numerous other areas of modern life.

How people study culture

The scientific study of human beings is called *anthropology*. One of the main branches of anthropology is cultural anthropology, which studies human cultures. The work of cultural anthropologists is *comparative* and



Young students use a computer as an educational tool. The invention of the computer has had enormous impact on modern life. Inventions are a major cause of cultural change.

cross-cultural—that is, cultural anthropologists study various societies to determine their cultural similarities and differences.

Cultural anthropologists study the artwork, houses, tools, and other material products of contemporary cultures. They also investigate the nonmaterial creations, including social groups, religious beliefs, symbols, and values. They gather information primarily by living for a time among the people they are studying and by observing them and talking with them. They organize the information into a scientific description called an *ethnography*.

Another main branch of anthropology is archaeology. It focuses on cultures of the past. Archaeologists study the remains of these cultures, including buildings, clothing, pottery, tools, and artwork. They trace the development of cultures by examining the things the people made and used. Archaeologists work at a specific site. They dig carefully for buried objects in a process called *excavation*. They describe whatever they find and take photographs of representative samples.

Archaeological research is the chief method available for learning about those societies that existed before the invention of writing about 5,500 years ago. However, some archaeologists choose to study later cultures, even contemporary cultures. For example, an archaeological project begun in 1973 in Tucson, Arizona, in the United States, has provided information about contemporary American life through a study of people's rubbish.

Other social scientists who study aspects of culture include sociologists and political scientists. They work mainly in a single urban, industrial society, and they make cross-cultural comparisons less often than anthropologists.

Related articles in *World Book*. See *Anthropology* and its list of *Related articles*. See also:

Acculturation
Assimilation
City (Cultural variety in cities)
Civilization
Communication (Cultural studies)
Cultural lag
Custom

Ethnic group
Ethnocentrism
Ethnography
Etiquette
Folklore
Language
Mores
Multiculturalism
Prehistoric people (The cultural development of human beings)
Social change
Socialization

Outline

- I. Characteristics of culture**
 - A. Satisfying basic needs
 - B. Learning
 - C. Using symbols
 - D. Forming patterns
- II. The boundaries of cultures**
- III. Culture and society**
 - A. Multiculturalism
 - B. Ethnocentrism and cultural relativism
- IV. How cultures change**
 - A. Contact with other cultures
 - B. Invention
- V. How people study culture**

Questions

What is enculturation?
What are the two main causes of cultural change?
How does the use of the term *culture* in a narrow sense differ from the broader definition used by social scientists?
What is a culture area?
Under what social and political conditions does multiculturalism succeed best?
What are the most important types of symbols?
How can one deal with culture shock?
What is the difference between a cultural trait and a cultural pattern?
What is ethnocentrism? In what ways can ethnocentrism be harmful?
How does acculturation differ from assimilation?

Culture, in biology, is a growth of microorganisms or cells produced under controlled conditions in a laboratory. Microorganisms grown in cultures include bacteria, viruses, and yeasts. A culture of plant or animal cells is known as a *cell culture*.

Cultures require sterile conditions to prevent contamination, and a suitable *culture medium* (substance that provides nutrients). A cell culture will grow and multiply if the culture medium meets its nutritional needs. If the *primary culture* becomes too crowded, the scientist can transfer part of the cells to a *secondary culture*. Cells ordinarily divide only a limited number of times and then die. Occasionally, however, a mutation occurs that enables them to grow indefinitely.

Cell cultures show how cells grow and function normally and thus can help scientists to understand more about cell abnormalities, such as those that occur in cancer and other diseases. Cultures of microorganisms can help doctors to diagnose diseases. For example, bacteria or viruses found in mucus or body tissue can be grown in a culture for identification. Cultures also are used to produce antibiotics, vaccines, and other drugs.

Culture shock. See *Culture*. How cultures differ.
Cumbernauld and Kilsyth pop. 61,042 is a local government district in Strathclyde Region, Scotland. It contains the whole of the new town of Cumbernauld.



Cumbria's Lake District is a beautiful region of mountains and lakes. The picturesque stream Ashness Gill, *above*, flows into Derwent Water, one of the area's largest lakes.

and the town of Kilsyth. Cumbernauld, designated a new town in 1955, is an overspill town for Glasgow. Its industries include light engineering, printing, warehousing and distribution, and the making of clothing, electronic equipment, and textiles.

Kilsyth is now mainly a *dormitory* town, and many of its inhabitants work in Cumbernauld, Falkirk, or Glasgow. Kilsyth developed as a centre of mining and quarrying, and of weaving, but these industries have declined. Many miners live in Kilsyth but work elsewhere. **Cumbria** is a beautiful, mountainous county in the northwestern corner of England. Its area includes the Lake District, one of the most famous tourist regions in Britain. The solitude and beauty of the Lake District have inspired many poets and writers, including William Wordsworth and Samuel Taylor Coleridge. Cumbria is one of the least populated areas of England.

The counties of Cumberland and Westmorland were formed in the area in the A.D. 1100's. In 1974, Cumberland and Westmorland were merged to form the county of Cumbria. The new county also took in part of northern Lancashire and a small part of the West Riding of Yorkshire.

People and government

Local customs and recreation. Water sports are popular in Cumbria. There are good facilities for sailing, fishing, and water skiing, especially on Bassenthwaite, Derwent Water, Ullswater, and Windermere. Two of England's main rock-climbing centres are Wasdale Head, near West Water, and Great Langdale, near Ambleside.

Local pastimes include the *guide race*, a rough scram-

ble up and down a steep *fellside* (hillside). *Hound-trailing* is a form of dog racing in which foxhounds follow a previously laid aniseed trail.

Wrestling in Cumbria has its own local rules. At the start of a round, two wrestlers stand closely locked, each clasping hands behind the other's back. The first wrestler to force his opponent to the ground wins.

Local government. Cumbria is divided into six local government districts: *Allerdale*, which includes the towns of Workington and Keswick; *Barrow-in-Furness*; *Carlisle*; *Copeland*, which includes Whitehaven; *Eden*, which includes Appleby and Penrith; and *South Lakeland*, which includes Kendal and much of the southern county. A single police force, the Cumbria Constabulary, covers the county. The crown court meets at Barrow-in-Furness, Carlisle, and Kendal.

Economy

Agriculture. Cumbria is mainly an agricultural area. The plain around Carlisle has farms producing cereals, root crops, dairy cows, and sheep. Farmers keep cattle in the southern lowlands. But farmers in hill areas

Facts in brief about Cumbria

Administrative centre: Carlisle.

Largest towns: Barrow-in-Furness, Carlisle, Workington, Whitehaven.

Area: 6,810 km².

Population: 1991 census—486,900.

Chief products: *Agriculture*—cereals, dairy and beef cattle, root crops, sheep. *Manufacturing and processing*—chemicals, clothes, leather goods, paper, shipbuilding, steel. *Mining and quarrying*—coal, granite, gypsum, limestone, slate.

mainly keep sheep. The Forestry Commission has many areas of woodland in Cumbria.

Manufacturing in Cumbria is concentrated in four main areas. They are the west coast, the Furness area, Kendal, and Carlisle.

West Cumbria's economy was once dependent on steel production. It is now less important, but the area has a factory producing steel rails, and a number of engineering factories. Newer industries include the production of chemicals, electronics goods, paper and board, and shoes. The nuclear industry at Sellafield is the area's largest employer. Its workers produce nuclear energy, or do research or service work.

The Furness area has major shipbuilding, paper, and pharmaceuticals industries. Kendal's main manufactures include shoes and high-quality paper. Carlisle has important food-processing, metal, and tyre industries. It is also a large administrative and shopping centre.

Mining and quarrying have been important in Cumbria for hundreds of years. Today's mining industry produces gypsum, and a few small mines produce coal. In West Cumbria there is large-scale opencast coal mining. Quarries in the county produce limestone, granite, sand, gravel, and slate.

Tourism is an important source of income in most of Cumbria. The Lake District accommodates many thousands of tourists each year.

Transport and communications. In the Lake District, the mountains and lakes make transport routes poor. Most of the main roads and railways bypass the Lake District. The M6 motorway, which takes much of the traffic between England and Scotland, runs through the east of the county. The motorway runs close to the main railway line linking England and Scotland.

Carlisle is the main communications centre of Cumbria. It has the headquarters of Border Television, an independent TV company, and has a daily and a weekly newspaper. Another daily newspaper is published at Barrow-in-Furness. BBC local radio stations broadcast from Barrow and Carlisle.



Cumbria is a county occupying the northwestern corner of England. It borders Scotland to the north.

Places to visit

Following are brief descriptions of some of Cumbria's interesting places to visit:

Ambleside, a centre for touring the Lake District, has a house built on a bridge in the 1700s.

Carlisle is a historic city with buildings from many ages. It also has its own racecourse.

Drigg is the entrance to Ravenglass Gullery Nature Reserve, which has Europe's largest colony of black-headed gulls.

Furness Abbey ruins are near Barrow-in-Furness, and date from the 1100s.

Grasmere has a William Wordsworth museum.

Hawkshead is a beautiful village. William Wordsworth attended its grammar school, built in 1585.

Kendal has many old buildings, including the ruins of a Norman castle that was the birthplace of Catherine Parr.

Lake District National Park, which takes up much of central Cumbria, includes many interesting ruins and old buildings and some of England's finest scenery.

Ravenglass has well-preserved Roman remains. The town is also the terminus of the Ravenglass and Eskdale scenic railway, on which some trains are steam-powered.

Ulverston has some attractive buildings, including Swarthmoor Hall, once the home of George Fox, who founded the Quaker Movement.

Land

Location and size. Cumbria's western boundary is the Irish Sea. To the north, it borders on the Scottish regions of Dumfries and Galloway, and Borders. To the east, the county borders on Northumberland, Durham, and North Yorkshire. To the south, it borders on Lancashire. Cumbria measures about 115 kilometres from north to south and 95 kilometres from east to west.

Land features. Much of Cumbria is taken up by the Lake District. This area consists mainly of the Cumbrian Mountains and steep-sided valleys of volcanic rock. The Cumbrian Mountains include England's highest peak, Scafell Pike, 978 metres above sea level. Other peaks are Scafell, 963 metres; Helvellyn, 950 metres; and Skiddaw, 931 metres. Eastern Cumbria includes part of the Pennine range, including Cross Fell, 893 metres, and Great Dun Fell, 847 metres. To the west and south of the Lake District lies a coastal strip of lowland. To the north, a plain spreads from the Solway Firth to the Pennines.

The largest lake in the Lake District, Windermere, lies in the south. The longest river flowing through Cumbria is the Eden. The Derwent, which flows in a semicircle, is the longest river in the Lake District.

Climate. Cumbria is one of England's wettest counties. It also has great variety in its climate. The coastal area is fairly warm and dry and has little snow in winter. In the mountains, some places have an annual rainfall of 4,500 millimetres. In eastern Cumbria, winters are severe and snowfalls are heavy. In the valleys of the Lake District, winters are usually mild. Average temperatures in the county are about 3°C in January and 15°C in July.

History

The earliest settlers in the area arrived between 1800 and 1500 B.C. The Romans were active in Cumbria, which they protected against invasion from the north by building Hadrian's Wall in the A.D. 100s. This huge defence work stretched from the Solway Firth across the whole of northern England (see **Hadrian's Wall**).

Between the 800's and the 1100's, Scandinavian people settled in the area. They gave the area most of its place names and many of the words in its dialect. Later the area was often in dispute between England and Scotland. During the English Civil War, Carlisle suffered one of the longest sieges in the history of England.

Cumbria is associated with many outstanding people. The portrait artist George Romney was born at Dalton-in-Furness. The poet William Wordsworth was born at Cockermouth, and later settled at Grasmere. Wordsworth, Samuel Taylor Coleridge, and Robert Southey, who also lived in Cumbria, are known as the Lake Poets. Other writers who have lived in Cumbria include John Ruskin and Beatrix Potter.

Related articles in *World Book* include:

Barrow-in-Furness	Ruskin, John
Carlisle	Scafell Pike
Coleridge, Samuel Taylor	Southey, Robert
Lake District	Windermere
Potter, Beatrix	Wordsworth, William
Romney, George	

Cummings, E. E. (1894-1962), was one of the most innovative poets in American literature. He is especially known for violating the rules of composition, rejecting punctuation and capitalization, distorting *syntax* (sentence structure), and experimenting with *typography* (the arrangement of printed matter). He wrote his own name as e. e. cummings. However, Cummings' themes and even many of his forms are traditional. Beneath his poems' complex surfaces are relatively simple, straightforward ideas. Cummings emphasized the supremacy of the individual over society, and he criticized the tendency of people to conform to socially accepted values and opinions. His poems show him to be joyous and childlike, a believer in love and spontaneity.



E. E. Cummings

Edward Estlin Cummings was born in Cambridge, Massachusetts. He studied at Harvard University. During World War I (1914-1918), Cummings served as a volunteer ambulance driver in France. French authorities suspected him of expressing treasonous views and held him in a French detention camp for three months. Cummings vividly described this experience in his book *The Enormous Room* (1922). Cummings published his first book of poems, *Tulips and Chimneys*, in 1923. Cummings also wrote verse plays such as *Him* (1928); *Elm* (1933), an account of a visit to the Soviet Union; *Santa Claus* (1946) and *six nonlectures* (1953), lectures originally delivered at Harvard. His *Complete Poems, 1904-1962* was published in 1991.

See also *Poetry* (Rhythm and metre).

Cumnock and Doon Valley (pop. 41,998) was a local government district in Strathclyde Region, Scotland. In 1996, it was replaced by East Ayrshire Council, and Strathclyde Region was abolished. The area is a collection of large villages and small towns lying some 65

kilometres from Glasgow. In its lower areas, the Doon Valley has rich farmland. The upper reaches consist of rough moorland. Dairy farming, forestry, sheep farming, and the growing of root crops, hay, and cereals are major agricultural activities.

Cumulus. See *Cloud*.

Cunard, Sir Samuel (1787-1865), a British merchant, founded the Cunard line of steamships. In 1838 he and two other British men formed a company for mail service between England and America by steam rather than by sailing vessels. The *Britannia* made the company's first voyage in 1840. Cunard was made a baronet for services the Cunard lines rendered to Great Britain in the Crimean War (1853-1856). He was born in Halifax, Nova Scotia, Canada.

Cuneiform was a system of writing used by the people of ancient Middle Eastern civilizations. It became widespread long before the development of modern alphabets. The word *cuneiform* comes from the Latin word *cuneus*, meaning *wedge*. Cuneiform characters are shaped like a wedge—broad at one end and pointed at the other.

Most cuneiform writings were inscribed in rectangular clay tablets. The characters were made with a *stylus*, a wedge-shaped tool, while the clay was still wet. The tablets were then dried in the sun until they hardened. The characters also were inscribed in metal and stone.

Scholars have had difficulty translating cuneiform writing because many of the characters represent either words or syllables. In addition, many ancient peoples developed their own interpretations of cuneiform symbols, and so one character may have several meanings.

Cuneiform was probably developed by the Sumerian people as a shortened form of picture writing. The earliest known cuneiform inscriptions were found in the lower Tigris-Euphrates Valley in what is now southeastern Iraq. They date from about 3000 B.C. The most recent cuneiform clay tablet was written about A.D. 75, near the beginning of the Christian Era.

Sumerian cuneiform symbols are more complex than those of other peoples. The Sumerians and Babylonians used about 600 characters, which ranged from a single

Examples of cuneiform writing

MEANING	Outline Character about 3000 B.C.	Cuneiform about 2000 B.C.	Assyrian about 700 B.C.	Babylonian about 500 B.C.
The Sun				
God or Heaven				
Mountain				
Man				
Ox				
Fish				

wedge to complicated signs consisting of 30 or more wedges. The Hittites used about 350 characters, the Elamites about 200, and the Persians only 39.

Scholars first attempted to translate cuneiform writing in the late 1700s. At that time, European travellers became interested in a cuneiform inscription discovered in western Iran. This inscription was written in three languages—Persian, Babylonian, and Elamite—and measured about 90 metres long. It was carved in a cliff called Behistun Rock. During the mid-1800s, Sir Henry Rawlinson, an English diplomat, first translated the Persian portion and later the Babylonian portion. They described the accomplishments of the Persian king Darius I in the late 500s B.C. The Elamite section was translated much later. The translations helped scholars decipher other cuneiform inscriptions.

Since 1800, several hundred thousand cuneiform clay tablets and stone inscriptions have been discovered. These inscriptions, which are on exhibit in museums throughout the world, help scholars broaden their knowledge about early human history.

See also **Communication** (picture: Cuneiform writing).

Cunha, Euclides da (1866-1909), a Brazilian newspaper reporter, wrote perhaps the greatest work in Brazilian literature. The book, *Os Sertões* (1902), has been translated as *Rebellion in the Backlands*.

In *Os Sertões*, Da Cunha realistically described an armed rebellion that occurred in 1896 and 1897. In this rebellion, Brazilians of the poverty-stricken *sertão* (backlands) fought against the government. Da Cunha witnessed the rebellion as a newspaper correspondent. *Os Sertões* combines journalistic reporting with certain features of a novel, such as characterization, drama, and pacing. The book gives a vivid account of guerrilla warfare. It also provides a sociological study of Brazilian society and its problems. In particular, the author attacked Brazilian society for its neglect of the people of the *sertão*. *Os Sertões* aroused public support for these people. It helped the wealthy residents of the coastal region understand the people of the *sertão*. Da Cunha was born in the state of Rio de Janeiro.

Cunjevoi is a kind of sea squirt found along the rocky coasts of the Australian states of New South Wales and Western Australia. The name is Aboriginal.

Cunjevois live in colonies between low- and high-tide marks. When they are uncovered at low spring tides, they close their two openings and retain a quantity of water inside their bodies. The water enables the cunjevoi to stay alive during the heat of the day.

Fishermen use cunjevois as bait. They cut off the tough purple-coloured outer *tunic* and use the soft reddish part of the body inside. See also **Sea squirt**.

Scientific classification. The cunjevoi belongs to the phylum Chordata, subphylum Tunicata, family Pyuridae. It is *Pyura praeputialis*.

Cunningham, Allan (1791-1839), was an explorer and botanist who became famous for his pioneering expeditions in eastern Australia. He made his most important discovery, the Darling Downs in eastern Australia, in 1827.

Early life. Cunningham was born at Wimbledon, in England. He worked as an assistant to the manager of Kew Gardens, in London. He settled in Sydney in 1816. On his first expedition, in 1823, he discovered Pandora's

Pass through the Liverpool Range. This pass provided a convenient route between Bathurst and the Liverpool Plains.

Discovery of the Darling Downs. In the 1820s, Moreton Bay was the only settlement, coastal or inland, to the north of the route followed by John Oxley, from the Warrumbungles to Port Macquarie, in 1818. Ralph Darling, Governor of the New South Wales colony, wished to find additional land for settlement. In 1827, Darling selected Cunningham to head an expedition to investigate the large tract of unknown territory that was situated to the north of the Liverpool Plains.

The party departed from Segenhoe, a homestead on the upper Hunter River, on April 30, 1827. When they reached the latitude of Oxley's 1818 track, they intended to continue to the Peel River, near Tamworth. But they were unable to take this route because intervening mountains proved too rugged for the heavily laden horses to climb. So the party proceeded northwards. But severe drought conditions became a hardship. Therefore, Cunningham led his party on a more easterly course.



Allan Cunningham

Once the party turned east, travelling conditions quickly began to deteriorate. Heavy rain began falling, and the expedition had to hack a path through dense thickets of wattle and pine. The vegetation gradually grew richer and more luxuriant. On June 5, the party had its first glimpse of a vast area of lush, rolling country that Cunningham named the *Darling Downs*.

Cunningham hoped to find a way through the mountains to reach the settlement at Moreton Bay. The party spent considerable time climbing ridges in the hope of sighting a pass to the coast. On June 11, Cunningham observed "a very singular deeply excavated part of the main range" that he thought might "provide a very practicable pass through these formidable mountains." Heavy rain and fatigue prevented Cunningham from exploring the gap himself. Instead, he sent two members of his party to examine the area more closely. They returned with a fairly favourable report.

Cunningham was tempted to try to cross through the pass. But the horses were weak, the scarp was extremely steep, and the provisions were shrinking. Therefore, he began the return journey.

Cunningham's Gap. In 1828, Cunningham prepared to return to Moreton Bay, determined to investigate more fully the pass he had glimpsed in the preceding year. He felt that discovering a convenient route from Moreton Bay to Darling Downs would greatly enhance the development of the downs as a pastoral and agricultural settlement. In addition, Cunningham was eager to study the vegetation of the Brisbane River.

On July 24, 1828, the expedition left Brisbane. The first task was to explore Mount Warning—whose exact position was unknown—and its surroundings. Cunningham was able to fix the location of the peak accurately. While



Allan Cunningham, an explorer, discovered the Darling Downs, in eastern Australia, in 1827. In 1828, he found Cunningham's Gap, a pass through mountains that separate Moreton Bay and the Darling Downs.

performing this duty, he also discovered Mount Lindsay. The expedition then travelled northwest until it approached the latitude of the pass. Dense thickets and the rugged Teviot Range prevented all attempts to cross in that direction. Cunningham headed for the settlement of Limestone Hills (now Ipswich) to reequip and rest.

Cunningham set out to locate and explore the pass he had seen in 1827. The party approached the range from the northeast. The difficult countryside slowed the journey. It was nearly four days before the expedition was able to reach the foot of the divide. Cunningham sent a man ahead of the party to examine a gap in the mountains. The man returned with the disappointing news that massive, sheer cliffs blocked the way. Other unsuccessful attempts to find the gap followed.

On August 24, a member of the expedition reported that he had descended into a pass. He said that from the pass he had sighted land that resembled the Darling Downs and Canning Downs. Cunningham explored the pass himself and confirmed that this was indeed the pass he had seen before. The discovery became universally known as *Cunningham's Gap*. A road was quickly constructed through the gap that opened the Darling Downs for settlement.

Final years. In 1831, Cunningham returned to England and spent time at Kew Gardens. There, he classified plant specimens that he had collected during his explorations. In 1837, he returned to Sydney to become Colonial Botanist of New South Wales. Cunningham resigned this post the same year and died in 1839. His remains are buried in Sydney's Botanic Gardens.

Cunningham, Andrew Brown (1883-1963), Viscount Cunningham of Hyndhope, was first sea lord and

chief of the British Naval Staff from 1943 to 1946. He was born in Dublin, Ireland, and joined the Royal Navy at the age of 15. He took command of the British Mediterranean Fleet in 1939 and then commanded the Allied Mediterranean Fleet during World War II (1939-1945). He rose to the rank of admiral of the fleet. Cunningham wrote of his experiences in his autobiography, *A Sailor's Odyssey* (1951).

Cunningham, Merce (1919-), is an American dancer and choreographer (dance composer). Cunningham often creates dances without advance knowledge of the music and the set designs that will accompany them. He became particularly known for his methods of *chance composition*. For example, in choreographing a dance, he would write the name of a movement, the name of a dancer, a length of time, and a space on the stage. Cunningham would then throw a dice or draw names from a bag to determine which dancer would do what movement for how long and where.

Cunningham was born in Centralia, Washington. From 1939 to 1945, he was a soloist with the Martha Graham company. In 1944, Cunningham began presenting dances in collaboration with the American composer John Cage. In 1953, Cunningham formed his own company with Cage as musical director. Cunningham has choreographed about 100 works.

Cunningham (pop. 134,676) is a local government district in Strathclyde Region, Scotland. It consists of a coastal plain on the Firth of Clyde, the Garnock valley and the islands of Arran and the Cumbraes. The main land area includes Irvine, a new town, and Largs and Saltcoats. Local industries include chemicals, electronics, engineering, and textiles. Tourism is important along the coast. There is a nuclear power station at Hunterston. See Strathclyde Region.

Cup moth is a small- to medium-sized, rather stout furry moth of dark colour. Australia has about 80 species of cup moths, most of which are tropical. Cup moth caterpillars are rather like slugs, with their heads retracted under their bodies. They appear to glide over the foliage on which they feed because they have shortened legs.



Merce Cunningham, centre, is a dancer and choreographer who leads one of the major modern dance companies in the United States.

Cup moths get their name from the cup-shaped cocoon of some species, such as that of the *mottled cup moth* of southeast Australia. The mottled cup moth can be a pest of fruit trees, such as apricots and cherries.

Most species of cup moths have bunches of sharp, brittle, stinging hairs. The hairs are normally folded away, but they are exposed and erected when the caterpillar is disturbed. Many cup moth caterpillars are brightly coloured, with a bold pattern that warns would-be attackers of the dangers of coming into contact with the defensive hairs.

Scientific classification. Cup moths belong to the family Limacodidae. The mottled cup moth is *Doratifera oxeys*.

Cupid was the Roman god of love. He is called Eros in Greek mythology.

The ancient Greeks and Romans described Cupid as having both a cruel and a happy nature. Cupid's cruelty came forth in his treatment of his wife, the beautiful princess Psyche. Cupid forbade Psyche ever to try to see what he looked like. He refused to be with her except at night in the dark. One night while Cupid was asleep, Psyche lit a lamp so she could look at him. Cupid awoke and fled in anger. But myths also describe Cupid as a happy, handsome lad who united lovers.

The earliest images of Cupid show him as a handsome, athletic young man. By the mid-300's B.C., he was portrayed as a chubby, naked infant with wings, holding a bow and arrows. A person shot with one of Cupid's arrows supposedly fell in love.

See also **Psyche**.

Cupola is a small dome that crowns a roof or tower. The word comes from a Latin word that means *cup*. Many cupolas resemble a small bowl turned upside down. The dome of the United States Capitol in Washington, D.C., is topped by a cupola. The inner vault of a large dome is also called a cupola.

Cuquenán Falls, on the Cuquenán River in Venezuela, is one of the three highest waterfalls in the world. The water drops 610 metres. Cuquenán stands near the Guyana border. The name of the falls is also spelled *Kukenaam*.

See also **Waterfall** (chart).

Curaçao is the largest island of the Netherlands Antilles—two groups of islands in the West Indies that belong to the Netherlands. For location, see **West Indies** (map).

Curaçao covers 443 square kilometres and has a population of about 170,000. Willemstad, the largest city on the island, is the capital of the Netherlands Antilles. A dry, nearly flat island, Curaçao has warm weather all year round, lovely beaches, and picturesque cities and towns. These features attract many tourists to the island. Most of Curaçao's people are blacks, or have mixed black and white ancestry. Oil refineries on Curaçao process crude oil from nearby Venezuela. Oil refining, tourism, and trade are the chief economic activities.

American Indians were Curaçao's first inhabitants. The Netherlands gained control of the island in 1634. From the 1600's to the 1800's, the Dutch brought many black African slaves to Curaçao.

See also **Netherlands Antilles**; **Willemstad**.

Curare is a poisonous extract from South American plants, mainly those of the *Chondodendron* and *Strychnos* species. Derivatives of curare are used in medicine

to relax the muscles during surgery and also for patients requiring mechanical ventilation.

South American Indians have used curare-tipped arrows for hunting for hundreds of years. When the poison enters an animal's bloodstream or body tissues, it paralyses the muscles, including those necessary for breathing. The animal suffocates as a result.

In 1856, the French physiologist Claude Bernard showed that curare works by blocking the passage of nerve impulses to voluntary muscle. In the second half of the 1800's, some doctors used curare in treating epilepsy and tetanus.

Curassow is a large, handsome bird of tropical America. The *bare-faced curassow* of northeastern Brazil looks somewhat like a turkey. The male bird's feathers are black, with a purplish-green gloss on the back and on the breast. The long feathers of its crest can be raised forward or lowered as easily as wings. The female has white on the crest and buff- to chestnut-coloured underparts. The curassow's bill is strong, and often has a raised knob on top. Curassows feed on nuts and fruits and range north to southeastern Mexico.

Scientific classification. Curassows belong to the guan family, Cracidae. The bare-faced curassow is *Crax fasciolata*.



A pair of bare-faced curassows perch on a branch. Curassows are heavy birds that feed on or near the forest floor.

Curd. See **Cheese** (How cheese is made).

Curfew is the time of day which once brought with it evening and the end of work. The word comes from the French expression *couvrefeu* which means *cover the fire*. At curfew, a bell was rung, telling people to put out their lights, cover their fires, and get off the streets until daybreak. William the Conqueror introduced the curfew in England during the 1000's. In 1103 Henry I repealed the curfew law, but the bell continued to be rung. It is still rung in some parts of Great Britain.

Some communities have curfew laws for adults during wartime. Persons of an enemy nationality must often be in their homes after a certain hour in wartime.

Curia regis was a group that helped kings govern during the Middle Ages. The group was often called the *King's Council* or *King's Court*. It consisted of leading barons, churchmen, and other officials. The court advised the king on important affairs of state, agreed to taxation and legislation, and served as a high court to settle difficult legal cases. The English Parliament and Cabinet, and European systems of administration and law, developed from it.

For normal government business, the king depended on his household officials and a few trusted barons and churchmen. This small group, also called *curia regis*, met daily.

Curie is a unit used to measure radioactivity. Its symbol is Ci. One curie equals 3.7×10^{10} nuclear disintegrations of any radioactive isotope per second. Nuclear disintegrations involve changes in a nucleus that occur when it gives off particles or rays. The radioactivity of a gram of radium equals about one curie. A *millicurie* is one-thousandth of a curie. The curie was named after the French physicist Pierre Curie.

Curie, Irène Joliot- See Joliot-Curie, Irène.

Curie, Marie Skłodowska (1867-1934), was a French physicist who became famous for her research on radioactivity. She received two Nobel Prizes—one for physics and one for chemistry.

Curie and her husband, Pierre, also a physicist, worked together studying the radiation given off by radioactive substances. They found that uranium ore contained much more radioactivity than could be accounted for by the uranium itself. The Curies then began to search for the source of the radioactivity. They separated minute amounts of two new highly radioactive chemical elements from tons of uranium ore, called *pitchblende*. The Curies named the elements *radium* and *polonium*. For this work, they and Antoine Henri Becquerel, a French physicist who discovered natural radioactivity, received the 1903 Nobel Prize for physics. In 1911, Marie Curie won the Nobel Prize for chemistry for her discovery of the new elements, and for her work in isolating radium and studying its chemical properties.

Curie helped found the Radium Institute (now the Curie Institute) in Paris in 1914 and served as its first director. She was born in Warsaw, Poland. Her maiden name was Marie Skłodowska. She studied mathematics, physics, and chemistry in Paris, where she became acquainted with Pierre Curie.

Curie, Pierre (1859-1906), was a French physicist known for his work in radioactivity. He and his wife, Marie, shared the 1903 Nobel Prize for physics with another French physicist, Antoine Henri Becquerel, for research on the radioactivity of uranium. The Curies, while studying uranium, discovered two highly radioactive chemical elements, *radium* and *polonium*. A co-worker, Gustave Bémont, helped in the work with radium.

Curie was born in Paris and studied and taught physics at the University of Paris. His early work involved research on the magnetic properties of metals. The temperature at which such properties suddenly change became known as the *Curie point*. In 1880, Curie and his brother Jacques published a paper about their discovery



Pierre and Marie Curie became famous for their work with radioactive elements. The photograph above shows the Curies cycling in the French countryside in 1896.

of the piezoelectric properties of crystals (see *Piezoelectricity*).

Curium is an artificially created radioactive element. Its atomic number is 96 and its chemical symbol is Cm.

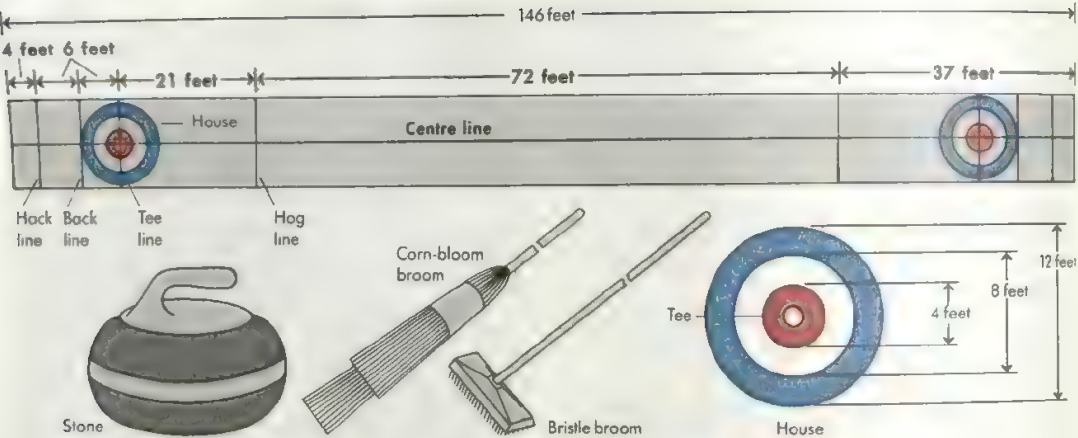
Curium has 14 known isotopes, the most stable of which has a mass number of 247 and a half-life of 10 million years (see *Radioactivity* [Half-life]). However, this isotope occurs in amounts too small for most experiments. Two other isotopes of the element are more readily available. One has a mass number of 244 and a half-life of 18 years. The other has a mass number of 248 and a half-life of 340,000 years. Curium melts at 1340°C . At 20°C , it has a density of 13.51 grams per cubic centimetre (see *Density*).

Curium was discovered in 1944 by the American scientists Glenn T. Seaborg, Ralph A. James, and Albert Ghiorso. They produced it by bombarding plutonium with helium ions in a cyclotron. The element is named after the French chemist Marie Curie.

See also **Element, Chemical** (table); **Transuranium element**; **Seaborg, Glenn T.**

Curlew is a long-legged wading bird related to sandpipers and snipes. Its long, slender bill, which curves downward, is used to probe for food in mud and sand. In the spring and summer it feeds mainly in wet pastures on insects, worms, and snails. In winter, it feeds mainly on the shore, on crabs, marine worms, and molluscs. Curlews nest on the ground, often far from water. They are found in Europe, Asia, and Australasia, and from arctic regions of North America to southern South America.

The *European curlew* is the largest wading bird. It has a brown, speckled plumage with a white rump, and is about 60 centimetres long. It can be seen on marshes and moors and around estuaries. The common curlew has a very distinctive territorial song. The song starts with low-pitched notes that rise in tone and tempo, and then dies away as the bird glides down on quivering wings.



Curling is played in a rectangular area on a level sheet of ice. A player stands on the *hack line* and slides a granite stone down the ice toward a target called the *house*. A team scores points by placing its stones closer to the *tee*, the centre of the house, than those of its opponents.

The *eastern curlew* of Australia resembles the European species but it lacks the white rump. Eastern curlews breed in Siberia and migrate to mudflats on the Australian coast and, occasionally, to New Zealand.

The *long-billed curlew* is one of the most common North American species. It breeds on Western plains and prairies. It is similar in size and colour to the European curlew. The tail is short and rounded, and the bill is about 20 centimetres long.

The *whimbrel* is a smaller species which breeds in northern Europe and North America. It has a high-pitched rippling call. In winter the American whimbrel, or *Hudsonian curlew*, migrates to South America. The rare *Eskimo curlew* is even smaller than the whimbrel.

Scientific classification. The curlew is in the sandpiper family, Scolopacidae. The European curlew is *Numenius arquata*. The eastern curlew is *N. madagascariensis*. The long-billed curlew is *N. americanus*. The whimbrel and the Hudsonian curlew are *N. phaeopus*. The Eskimo curlew is *N. borealis*.

See also Sandpiper; Snipe.



Curlews have long, curved bills for probing in mud and sand for food. The long-billed curlew is common in North America.

Curling is a game played on a level sheet of ice. Two four-player teams compete on a sheet of ice 146 feet (44.5 metres) long and a minimum of 15 feet 7 inches (4.75 metres) wide. The players slide stones on the ice toward a target. Curling probably began in Scotland and the Netherlands about 400 years ago.

The game. Each player slides two stones toward the *house* (target), a 12-foot (3.7-metre) circle at the far end of the ice. The competitors deliver one stone at a time, alternating with their opponents. When all 16 stones have been delivered, a period called an *end* has been played. A game usually consists of 8 or 10 ends. The stones of one team that are closer to the house's centre than any stones of the opposing team score one point each. The opposing team receives no points in that end.

Players deliver the stones from a *hack* (foothold) 126 feet (38 metres) from the centre of the house at the far end of the ice. The stones used in most regulation matches weigh 42½ pounds (19.3 kilograms). Each stone has a handle on top.

To deliver the stone, the player puts one foot in the hack, then crouches with the feet together. The stone rests on the ice to the player's side. Grasping the handle, the player slides the stone straight back and rises from a crouching position. The stone comes up off the ice during the backswing. Then, as the arm and stone swing forward, the player turns the hand either in or out. This action causes the stone to turn as it is released, and it *curls* (curves) to the right or left as it slides along. The game gets its name from this action.

The team. In club competition, a team is composed of a *lead*, a No. 2 player, a No. 3 player, and the *skip* or captain. They deliver the stones in that order. The lead, who is usually the least experienced player, goes first because it is simpler to deliver with no stones on the ice. In curling tournaments, called *bonspiels*, and in national and international competition, a team consists of four experienced players.

Before the first player delivers, the skip moves to the house at the far end of the ice. The skip indicates with a broom the spot at which the stones should be aimed. After each stone is delivered, the skip judges its speed.



Curling players sweep the ice ahead of a sliding stone delivered by a teammate. Sweeping enables the stone to travel farther on the ice. The player on the right directs the sweepers.

If it appears that the stone will fall short of the target, the skip shouts, "Sweep." The other two players then move ahead of the sliding stone, sweeping the ice with their brooms. Sweeping alters the ice surface and lessens resistance to the stone. It can add 2 to 3 metres to a delivery. Players may use brooms with short, fine bristles or ones with long, stiffer bristles. The skip shouts "Brooms up" to command the sweepers to stop sweeping. After delivering two stones, a player joins a teammate in sweeping for the other members of the team.

Curly-coated retriever is a dog trained to bring back game that has been shot. It is primarily a water retriever, and is particularly popular in Australia and New Zealand. It gets its name from its distinctive black or liver-coloured coat, which is a mass of thick, tight curls. This coat keeps the dog from getting chilled while swimming. The dog will work in cold water for a long time. It stands about 65 centimetres high at the shoulder, and weighs from 30 to 35 kilograms. A curly-coat is fairly easy to train, and makes a good guard or watchdog. See also Retriever.



The curly-coated retriever gets its name from its dark coat of thick, tight curls. It makes a good hunting dog or watchdog.

Currant is a small berry that grows on a low, bushy shrub. Currants are round and smooth, and they have a sour flavour. Their colours include black, red, gold, and white. Currant plants grow best in northern regions where the weather is generally cool and humid.

Red currants and black currants are popular in northern Europe, where they grow wild. Red currants are used for jellies, jams, wines, and pies. Black currants have a sharper flavour and are used mainly for making juice. They are rich in vitamin A. The golden currant of western North America has black berries and leaves that turn orange-yellow in the autumn. Several kinds of flowering currants are grown as ornamental plants for their flowers and leaves, which smell of blackcurrants.

Currant plants serve as host plants for a disease called *pine blister rust fungus*. This disease is harmful to pines and similar conifer trees. For this reason, the authorities ban the growing of currant plants in many areas of the world.

Scientific classification. Currants belong to the family Grossulariaceae. The red currant and white currant are *Ribes rubrum*. The black currant is *R. nigrum*; the golden currant, *R. aureum*.

See also Gooseberry.

Currawong is a large bird belonging to the Australian crow-shrike family. Currawongs are about 50 centimetres long, with strong bills and yellow eyes. They are black, black and white, or grey. Currawongs live in eastern Australia from Cape York to Tasmania and Lord Howe Island and across southern Australia.

The six main kinds of currawongs belong to two species, pied currawongs and grey currawongs. Their name is derived from the call *curra-wa-currawong* of the pied currawong.

Scientific classification. Currawongs belong to the family Cracticidae, genus *Strepera*. The pied, Lord Howe Island and black currawong are *S. graculina*. The grey, black-winged, and brown currawong are *S. versicolor*.

Currency. See Money.

Current, Electric. See Electric current.

Currents, Ocean. See Ocean (How the ocean moves).

Currier and Ives was a firm of American lithographers. The company published more than 7,000 colour pictures showing the manners, customs, and sports of the times; the California gold rush; railways and clipper ships; fires; and other historic events. The prints were widely used for decoration and for illustration. Although they were published at low cost, these prints later became rare and costly.

Nathaniel Currier (1813-1888), the senior member of the partnership, issued his first two prints in 1835 in New York City. They were *The Ruins of the Merchants' Exchange* and *View of the Great Conflagration*. Currier was born in Roxbury, Massachusetts. He served as apprentice to William S. and John B. Pendleton, brothers who operated the first lithographing shop in Boston, before he opened his own shop in New York.

James Merritt Ives (1824-1895) served first as bookkeeper and later as artist and art director of the firm. After 1857, all of the prints published by the firm carried the joint name. Currier retired from the company in 1880, and Ives carried on the business with William Currier, the son of Nathaniel. Ives was born in New York City.

Curry is a stewlike dish of eggs, fish, meat, or vegetables seasoned with a blend of spices. In many Western nations, some cooks use *curry powder*, a standard mixture of several ground spices, in making curries. However, curry powder is rarely used in India and Pakistan, the countries where curry cooking originated. There, the selection of seasonings varies with each dish but generally includes chilli peppers, coriander, cumin, and turmeric. Some curries also include such seasonings as cardamom, cinnamon, cloves, fennel seeds, fenugreek seeds, ginger, and mustard seeds. Curries range in taste from hot and tangy to mild and sweet.

Curry, John Stuart (1897-1946), an American painter, became famous for his dramatic scenes of Midwestern rural life. He admired this life for what he considered its enduring goodness and simplicity. The best known of his works include *Baptism in Kansas* (1928) and *Tornado over Kansas* (1929). Curry belonged to the art movement of the 1930's known as *regionalism*. This movement attempted to portray the American scene during the hard times of the Great Depression. He painted murals for the U.S. Department of Justice and the Department of the Interior buildings in Washington, D.C., and for the Kansas Capitol in Topeka.

Curry was born in Dunavant, Kansas. He studied at the Kansas Art Institute, at the Art Institute of Chicago, and then for a year in Paris.

Curtin, John (1885-1945), served as prime minister of Australia from 1941 to 1945. During this time, World War II (1939-1945) presented Australia with the greatest threat to its security in its history.

Curtin led the Australian Labor Party. He became prime minister in October 1941, after the fall of Arthur Fadden's Country Party-United Australian Party coalition.

Early life. John Joseph Ambrose Curtin was born at the small town of Creswick, in Victoria, on Jan. 8, 1885. He received little formal education and left school at the age of 13. He educated himself largely after he left school.

In the early 1900's, Curtin joined the Socialist Party of Victoria. In 1911, he became secretary of the Timber Workers' Union in Victoria. In 1917, he accepted a position as editor of the *Westralian Worker*. This was a weekly Labor paper, published in Perth, Western Australia. In the same year, Curtin married Elsie Needham.

Member of Parliament. Curtin's parliamentary career began in 1928. He was elected to the federal Parliament for the seat of Fremantle in Western Australia. In 1929, a Labor government was returned to power under the leadership of James Scullin. Curtin was among those Labor members who lost their seats when Labor lost power at the general election of 1931. In 1934, he regained the seat of Fremantle. In 1935, James Scullin became ill, and the Labor Party had to find a new leader. John Curtin was elected leader of the parliamentary party. He took over as leader of the opposition on Oct. 1, 1935.



John Curtin

When war broke out in September 1939, Curtin supported the Robert Menzies government in its immediate pledge of assistance to Britain.

Prime minister. In October 1941, Arthur Fadden's government lost support in the House of Representatives, and the Labor Party came to power.

As prime minister, Curtin soon realized that the steps taken by the previous government still left Australia ill-prepared to face a powerful enemy. The threat from Japan particularly worried him. Curtin's fears were confirmed on Dec. 7, 1941. Without warning, the Japanese attacked the United States naval base of Pearl Harbor. They also attacked other important United States and British bases in Southeast Asia. At the end of 1941, Curtin wrote an article appealing to the United States for help in the fight against Japan. Then Singapore fell to the Japanese in February 1942. With the swift Japanese advance southwards, his call for American assistance assumed a new significance. In March 1942, American General Douglas MacArthur arrived in Australia and announced that Australia would provide a base for operations to be launched against Japan.

Britain and Australia had depended heavily on Singapore. After it fell to the advancing Japanese troops, Curtin insisted that Australian troops in the Middle East should come home to defend their own country. Australian troops returned to Australia early in 1942, in time to confront the Japanese in Papua New Guinea.

In the election of 1943, the Labor government under John Curtin was returned to power. Early in 1944, Curtin's health became worse, and, in October of that year, he suffered a heart attack. Although he recovered sufficiently to resume his duties as prime minister, he was never strong again. In April 1945, he became ill again, and he died on July 5, 1945.

See also *Australia, History of* (World War II).

Curtis, Charles G. See *Turbine* (History).

Curtis, Dame Myra (1886-1971), a British academic, was principal of Newnham College, Cambridge University, England, from 1942 to 1954. In 1946, she headed a committee that produced an important report on deprived children. She was born in Sunderland and educated at Winchester School for Girls and at Cambridge University. She was created a Dame Commander of the Order of the British Empire in 1949.

Curtiss, Glenn Hammond (1878-1930), an American inventor, was a manufacturer of aeroplanes, and made thousands of planes during World War I (1914-1918). His *Wasp* held a number of records. In 1919, a Navy-Curtiss flying boat, commanded by Albert C. Read, made the first flight across the Atlantic Ocean.

Curtiss was born in Hammondsport, New York, and educated in the town's elementary schools. An interest in bicycle racing as a boy led to his flying career. From bicycles he turned to building motorcycles, one of which he raced at 220 kilometres per hour. In 1904, he began building



Glenn Hammond Curtiss

engines for the first U.S. dirigibles, designed by Thomas Scott Baldwin. Curtiss built his aeroplane engine in 1907, as a member of Alexander Graham Bell's Aerial Experiment Association. In 1908, he helped design an aeroplane called the *June Bug*. It had a box tail and was controlled by *ailerons* (hinged flaps on the wings). Orville and Wilbur Wright had obtained a patent on a method of twisting wings to control flight. They claimed Curtiss's ailerons violated their patent. They won a court case against Curtiss.

In 1910, Curtiss won 10,000 U.S. dollars by flying one of his planes from Albany, New York, to New York City in 2 hours 51 minutes. He built the first planes for the United States Navy in 1911 after demonstrating that planes could land and take off from ships.

See also **Aeroplane** (picture: *The June Bug*).

Curve. See **Parabola**; **Circle**; **Bowling**.

Curzon, Lord (1859-1925), Marquis of Kedleston, a British statesman, was a Conservative Party politician. He was viceroy of India from 1899 to 1905, and later became chancellor of Oxford University. Curzon re-entered politics during World War I (1914-1918). He became a member of Lloyd George's war cabinet in 1916. In 1919, he became foreign secretary, but received a setback when Lloyd George's government fell in 1923. He expected to become prime minister but was passed over in favour of Stanley Baldwin. George Nathaniel Curzon was born at Kedleston, in Derbyshire, England.



Lord Curzon

Curzon, Sir Clifford (1907-1982), was a British pianist. He won acclaim particularly for his intellectual grasp of music, attention to detail, and for the driving intensity of his musical expression. His technique at the keyboard was masterly. Clifford Michael Curzon was born in London. He attended the Royal Academy of Music in London and also studied in Berlin and Paris. He was knighted in 1977.

Curzon Line was the eastern boundary of Poland proposed by the Allies in 1919, after World War I (1914-1918). It was named after Lord Curzon, a British diplomat. Before the war, Poland had been divided among Austria-Hungary, Germany, and Russia. The Curzon Line was to be the frontier between Russia and a new Poland. Both countries rejected the plan, and fighting broke out in 1920. The Treaty of Riga in 1921 moved the border east of the Curzon Line. The line is now the boundary separating Poland from Belarus and Ukraine.

Cusco (pop. 255,300), also spelled *Cuzco*, is a city in the southern Andes Mountains of Peru. For location, see **Peru** (political map). The city lies about 3,400 metres above sea level. Cusco was the capital of the Inca Empire. Francisco Pizarro, a Spanish soldier, conquered it in 1533. Cusco has many Inca and Spanish colonial buildings, and the ancient Inca city of Machu Picchu is nearby. Cusco is a trading centre for nearby farmers. The city is also a centre of tourism.



The **cuscus** is a mammal of Australia, New Guinea, and nearby islands. The lower part of its tail is hairless and has scales.

Cuscus is a tree-dwelling mammal that lives on the northern tip of Australia and in New Guinea and the nearby islands of Sulawesi and the Solomon Islands. It grows about 60 centimetres long, not including the tail. Cuscuses have large eyes, tiny ears, and woolly fur. The fur may be brown, grey, or white, or it may be spotted or striped. The hairless tip of the tail is scaly.

Cuscuses move slowly and are most active at night. They eat chiefly fruits and leaves. Cuscuses are *marsupials*. Female marsupials give birth to tiny, poorly developed offspring. Like most marsupials, young cuscuses are carried in a pouch on the mother's belly until they develop more completely.

Scientific classification. Cuscuses belong to the marsupial family, *Phalangeridae*.

Cush. See **Kush**.

Cushing, Harvey (1869-1939), an American doctor and surgeon, was one of the world's greatest brain surgeons. He won fame for his achievements in neurosurgery and for experimental work on the brain, nervous system, and pituitary gland.

In 1926, Cushing won a Pulitzer Prize for biography for *The Life of Sir William Osler* (1925), the life story of his friend and fellow doctor. His other writings include *The Pituitary Body and Its Disorders* (1912), *Tumors of the Nervous Acoustic* (1917), and *From a Surgeon's Journal, 1915-1918* (1938).

Cushing joined Johns Hopkins University in 1896. He was professionally connected with the university until 1911, when he became professor of surgery at Harvard University. He was born in Cleveland, Ohio.

Cuspid. See **Teeth** (Permanent teeth).

Custard apple is the fruit of a small tropical American tree. The custard apple or *bullock's heart* is almost round in shape, measuring 7 to 12 centimetres across. The skin of the fruit is dark brown and has a rough scaly rind. The flesh is fibrous, sweet, and creamy white. The fruit has a number of large seeds. Custard apples are grown throughout the tropics. The fruits are also eaten by bats, monkeys, and squirrels.

Related edible fruits include the *cherimoya*, *soursop*, and *sweetsop*. The *cherimoya* has a greenish-purple skin with creamy-white flesh and inedible black seeds. It



Fruit related to the custard apple include the cherimoya, left, which has a scaly, greenish-purple skin; and the sweetsop, right, which is deeply lobed like a fir cone.

has a sour-sweet flavour. The soursop is a pear-shaped fruit weighing up to 600 grams. The skin is covered with warts or soft thorns. The flesh is spongy, very succulent, and very sweet. Sweetsop, also called *sugar apple*, is heart shaped. The fruit, divided into lobes, has creamy-yellow flesh and many seeds. Custard apple, cherimoya, sweetsop, and soursop belong to a primitive group of flowering plants related to magnolias.

Scientific classification. Custard apple and related fruit belong to the family Annonaceae. Custard apple is *Annona reticulata*; cherimoya is *A. cherimoya*; soursop is *A. muricata*; and sweetsop is *A. squamosa*.

Custer, George Armstrong (1839-1876), was a United States Army officer who won fame as an American Civil War general and an Indian fighter. Custer is best known for his role in the Battle of the Little Bighorn on June 25, 1876, in the Montana Territory. In this battle, which is also known as "Custer's Last Stand," Sioux and Cheyenne Indians killed Custer and all of the men under his direct command. The battle became famous because of disagreement over the reasons for Custer's defeat.

Early career. Custer was born in New Rumley, Ohio. He graduated from the U.S. Military Academy in 1861, ranking last in his class. But during the Civil War, which had just begun, Custer quickly gained attention as a fearless cavalry leader. In 1863, at the age of 23, he was made a brigadier general, and in 1865, a major general, both temporary ranks.

Many who served with the bold "boy general" admired his bravery and success. Many others felt that Custer was overly proud and too sure of his abilities. Some of his enemies were jealous of him and called Custer a "glory hunter." But he captured the public's attention and became a hero in the North.

After the Civil War ended in 1865, the Army dropped Custer to his regular rank of captain. He joined the Seventh Cavalry Regiment in 1866 as a lieutenant colonel. Custer won greater fame and made more enemies while fighting Indians in the Southwest and in the Dakota and Montana territories.

The 1876 campaign. In early 1876, Custer's regiment joined troops organized to round up the Sioux and Cheyenne Indians and move them to reservations. Gen-

eral Alfred H. Terry commanded the expedition. In June, the main part of the army force reached an area in the Montana Territory where Terry expected to find the Sioux Indians. Terry ordered Custer's regiment to get in a position south of the Indians.

On the morning of June 25, Custer's scouts found an Indian village about 24 kilometres away. It lay in the valley along the Little Bighorn River. Custer expected to find about 1,000 warriors. He believed his 650 soldiers could easily capture the village. But the camp really had at least 2,000 warriors. This group, whose leaders included Crazy Horse, Gall, and Sitting Bull, was probably the largest gathering of Indian warriors in Western history.



George A. Custer

The battle. Custer decided to attack immediately. He divided his regiment into three main groups—one under Captain Frederick W. Benteen, one under Major Marcus A. Reno, and one under himself. He sent Benteen to the south to prevent Indians from escaping in that direction. He ordered Reno to cross the river and attack the village. Custer's group turned north and went downstream, probably to attack a weak point in the village.

After bloody fighting in the valley, Reno's badly beaten troops retreated up the hills on the other side of the river. Benteen's group joined Reno's men there. About 7 kilometres away, the Indians killed Custer and his entire unit of approximately 210 soldiers. The fighting may have lasted only one hour. The Indians fought Benteen and Reno's troops until June 26. Later that day the Indians disbanded their camp and left the territory. Terry arrived with his soldiers on June 27.

The controversy. Americans found it almost impossible to believe that any group of Indians could have killed such a well-known officer and all his men. Custer's enemies accused him of disobeying Terry by attacking the Indians without waiting for the main body of soldiers. Custer's supporters charged that Reno had been a coward, and could have rescued Custer if he had not retreated. Others blamed Terry and his aides for not knowing the size of the Indian force. Historians still argue about the reasons for Custer's defeat.

See also **Crazy Horse; Indian wars** (The Sioux wars); **Sitting Bull**.

Custom is a practice or a way of doing things that has been handed down from one generation to the next. Customs are part of the culture shared by members of a social group. Many customs begin because people like to know what to expect in social situations. Like all cultural traits, customs are a form of learned behaviour, and they differ among different peoples. For example, eating is a biological requirement for all people, but table manners and customs of food preparation vary from group to group.

Practices that change frequently are called *fashions*. They include social dances, styles of dress, and slang ex-

pressions. A fashion may become a custom through long usage. For example, eating with a fork was a fashion in Europe during the 1500's, but it is now a custom throughout the Western world.

Customs last partly because people often find it easier to conform than to face the disapproval of their social group. Such disapproval may range from mild ridicule to severe punishment. Many customs produce only mild reactions when broken. Such customs include many wedding and funeral traditions and rules of etiquette.

Important customs that reflect a society's ideas of right and wrong are called *mores*. Examples include the reaction of people to murder or cannibalism, which produce anger and shock. Many people believe that their society's welfare depends on enforcement of its mores. As a result, most societies enact laws that reflect existing mores or are intended to establish new ones.

In isolated, nonindustrial communities, most customs remain unchanged from generation to generation. The majority of people in such societies believe the old ways are best—and what was good for the parents is good for the children. In modern industrial societies, however, customs change more easily. A number of factors, including new inventions and contact with other cultures, may lead to such changes.

Related articles. See the country articles in which customs are discussed, such as India (Way of life). See also:

Clothing (Clothing around the world)	Folklore (Superstitions and customs)	Holiday Mores
Etiquette	Food	Rite of passage
Fashion	Funeral customs	Taboo
Feasts and festivals		

Customs are duties paid to a nation's government on items that people bring in from another country. Each nation has its own regulations regarding the quantity and kinds of articles that may be imported.

Customs inspectors may examine the baggage of all travellers returning to a country. All articles acquired abroad that are subject to customs duties must be *declared*—that is, they must be identified and their value given to an inspector. If a person fails to declare an article or understates its value, the article may be taken away and the individual may be fined.

Certain articles are *exempt* (free) from customs duties. Most countries allow people to bring in goods up to a certain value. They also allow a specified quantity of alcoholic beverages and tobacco products if they are bought *duty free* during the journey or in another country. However, the law may require that the traveller has been away for a minimum time.

Articles which are prohibited from being brought into many countries include illegal drugs, obscene publications, and certain knives or other offensive weapons. Guns and other firearms normally need a special certificate. Fruit, vegetables, meat, plants, and seeds are restricted or prohibited in some countries to prevent the spread of disease. Animals entering the United Kingdom must undergo a period of quarantine in order to prevent the disease rabies being brought into the country.

Countries usually impose customs duties at a rate that depends on the value of the article and its quantity. However, there are different ways of working out this value, depending on whether or not the value includes

the cost of transporting the article from the country where it originated. Some countries have joined together to form customs unions, whereby they do not charge duties on goods from each other's countries, and impose uniform duties on outside countries.

See also **Customs union; Smuggling; Tariff.**

Customs union is an association of two or more countries which agree to eliminate duties, quotas, and any other barriers to trade among themselves. Members of the union apply a single set of tariffs to all countries outside the union. A *free trade area* is like a customs union, except that the members of a free trade area set their own different tariffs against nonmembers.

The best-known customs unions have included the Zollverein, Benelux, and the European Economic Community (now called the European Union). The Zollverein was formed by German states in the 1830's. These states became the German nation in 1871. Belgium, the Netherlands, and Luxembourg established Benelux in the 1940's. Belgium, France, Italy, Luxembourg, the Netherlands, and West Germany set up the European Economic Community (EEC) in 1957. Denmark, Ireland, and the United Kingdom joined the EEC in 1973, Greece joined in 1981, and Portugal and Spain joined in 1986.

See also **Benelux; European Free Trade Association; European Union.**

Cutch. See **Catchu.**

Cuthbert, Betty (1938-), an Australian

sprinter, won four gold medals at Olympic Games. In 1956, at the Olympic Games in Melbourne, Australia, she won three gold medals. She won the 100 metres and 200 metres, and was a member of the women's team that won the 4 × 100 metres relay. Between 1956 and 1963, she set world records for distances ranging from 60 metres to 440 yards (402.3 metres). In 1964, she won a fourth gold medal in the 400 metres at the Tokyo Olympics. She was born in Sydney.

Cuticle. See **Hair** (The structure and growth of hair).

Cutler, Sir Roden (1916-), was governor of New South Wales, Australia, from 1966 to 1981. He was born in Sydney, and educated at Sydney University. In 1941, during World War II (1939-1945), he was awarded the Victoria Cross for exceptional courage in fighting near Merdjayoun in Syria. Cutler took three machine-gun nests and also captured eight prisoners single-handedly. He later lost a leg during further combat in the same area. From 1946 to 1966, Cutler held a number of diplomatic posts. He was knighted in 1965.



Betty Cuthbert



Sir Roden Cutler

Cutting. See Plant (Asexual reproduction).

Cuttlefish is a *mollusc* (soft boneless animal) in the same class as the squid. It is found in most seas except those surrounding the Americas. It usually lives in deep water, but it is sometimes found near the shore. It ranges in size from about 8 centimetres to about 1.8 metres long. The body is brown with crossbands and purple spots. It is brilliantly metallic in the sunlight and often changes colour. The cuttlefish's oval body is surrounded with a frilled fin.

The cuttlefish has eight short arms and two long *tentacles* (feelers) that surround the mouth. Both the arms and the tentacles have four rows of hard and rough suckers. The tentacles can be pulled into pockets behind the eyes. The cuttlefish uses its arms to attach itself to objects, and to capture smaller marine animals such as crabs and fish.



The cuttlefish has a broad head with two large eyes. It has eight short arms and two long tentacles surrounding the mouth.

The cuttlefish has an internal shell called the *cuttlebone*. The broad cuttlebone is spongy and chalky. It is fed to canaries and parrots because of its high calcium content. It is also used in making toothpaste.

The cuttlefish moves by forcing water in or out of the space between the cuttlebone and body. It also uses its siphon to blow water jets over sandy bottoms to expose crabs buried in the sand. To hide from its enemies, the cuttlefish can darken the water as it moves by pouring out an inky substance containing the brown *pigment* (colouring matter) called *sepia*. Ink made from *sepia* was widely used in ancient times.

Scientific classification. The common cuttlefish is in the cuttlefish family, *Sepiidae*. It is *Sepia officinalis*.

See also *Mollusc*; *Nautilus*; *Octopus*; *Squid*.

Cutty Sark is a clipper ship preserved at Greenwich, in London. The *Cutty Sark* was one of the fastest sailing ships ever built. It was designed for carrying tea from China. It was built on the Clyde, at Dumbarton, Scotland, and launched in 1869. The *Cutty Sark* measured 64.5 metres in length and 11 metres in width. It had a sail area of 3,000 square metres, a large area in proportion to its size. The *Cutty Sark* had a maximum speed of 31 kilometres per hour (17 knots), a good rate for a sailing ship of the time.

During the years it was employed in the tea trade, the *Cutty Sark* proved exceptionally fast but could not match the speed of its rival, the *Thermopylae*. Later, the *Cutty Sark* became the fastest of the clippers in the Australian wool trade. In 1895, it became the Portuguese *Ferreira*. It

returned to British ownership in 1922. In the following years, it was moored first at Falmouth, in Cornwall, and then at Greenhithe, in Kent, before being removed to Greenwich. It was put on public exhibition in 1957.

See also *Clipper ship* (picture).

Cutworm is the caterpillar of certain dull-coloured, night-flying moths. Cutworms have a smooth skin and vary in colour from light grey to black. Some are striped or spotted. Cutworms are quite destructive. Groups of cutworms have been known to destroy entire fields of young wheat, maize, or garden vegetables overnight. Cutworms also may cause a great deal of damage to tobacco, cotton, and various kinds of fruit trees.

From one to four generations of cutworms may grow each year. Some spend the winter as pupae, others as larvae. Solitary cutworms feed beneath the soil. Climbing cutworms crawl up the plants at night to feed. Gardeners kill cutworms with poisoned baits and sprays.

Scientific classification. Cutworms are in the owl moth family, *Noctuidae*.

See also *Moth*.

Cuvier, Baron (1769-1832), was a French naturalist. He excelled in *comparative anatomy*, a branch of zoology that compares the structure of animals. Cuvier pioneered the founding of *palaeontology* (the study of fossils) when his comparisons led him to the fossil remains of prehistoric animals. He wrote *The Animal Kingdom*, an authoritative source on zoology.

Cuvier began his work by dissecting animals from the sea. He then dissected many large animals, including the rhinoceros and the elephant. He could usually identify an animal from a single bone or body organ. Cuvier proposed the theory of *geological catastrophes* to explain why many fossil animals were no longer alive. This theory held that great volcanic upheavals and similar catastrophes destroyed many forms of life.

Georges Léopold Chrétien Frédéric Dagobert Cuvier was born in Montbéliard, France. He began to study sea animals on the Normandy coast. He later taught at the College of France.

See also *Zoology* (History).

Cuzco. See *Cusco*.

Cwmbran. See *Gwent*.

Cyanide is the name given to metal salts containing the CN group (a carbon atom linked to a nitrogen atom). Sodium cyanide (NaCN) and potassium cyanide (KCN) are important industrial chemicals. Both are used in the cyanide process of separating gold and silver from their ores, and in the hardening of steel. Strong acids react with metal cyanides to make hydrogen cyanide (HCN), a deadly poison gas. Organic cyanides are *nitriles*. Acrylonitrile, important in the manufacture of fabrics, plastics, and synthetic rubber, is made from cyanide. Chemists use cyanide in solutions for electroplating and in the production of drugs and other chemicals. See also *Gas chamber*; *Prussic acid*.

Cyanite. See *Kyanite*.

Cyanosis is a bluish discoloration of the skin and mucous membranes. Cyanosis results if the blood flowing through vessels in the skin and mucous membranes contains too much *reduced haemoglobin*—that is, haemoglobin not combined with oxygen. Haemoglobin is the compound in red blood cells that carries oxygen. When combined with oxygen, haemoglobin makes

blood bright red. Blood containing large amounts of reduced haemoglobin appears bluish when seen through the skin and mucous membranes.

Cyanosis may occur among people who live at high altitudes, where the air contains less than the normal amount of oxygen. It may result from heart and lung ailments that prevent blood from combining properly with oxygen. For example, *blue babies* have cyanosis because a heart defect prevents some blood from entering their lungs to receive oxygen (see *Blue baby*). Cyanosis also can occur when blood circulates poorly after a person goes into shock or suffers heart failure.

Cyanosis resulting from too little oxygen may be treated by improving the patient's respiration or by using an oxygen tent or mask. Doctors treat cyanosis caused by poor circulation by increasing the rate of the blood flow.

Cybernetics is the study of control and communication in machines and animals. Norbert Wiener, an American mathematician, introduced the term *cybernetics* in his book of the same name, first published in the United States in 1948.

Wiener's book described the similarities in the functioning of human beings and machines. Wiener and others had observed that both people and machines were purposeful and orderly, sought stability, and used information. One of their most important shared characteristics, according to Wiener, was the use of *feedback*. Feedback involves the circling back of information to a control device to adjust behaviour. For example, when the body temperature of a human being is too high or too low, this information is *fed back* to the brain. The brain then acts to correct the temperature. A household thermostat uses feedback when it corrects the operation of a furnace to maintain a set temperature.

Cybernetics has prompted attempts to build machines that imitate human behaviour, including decision-making and analysis of data. Because such machines accomplish more than the simple mechanization of work, some theorists argue that cybernetics has started a second industrial revolution. Since the 1940's, the ideas of cybernetics have influenced such diverse fields as biochemistry, computer science, and psychology.

Cycad is a plant that grows in regions of the world with tropical and subtropical climates. Cycads look like palms or ferns and may grow up to 20 metres tall.

There are about 100 species. Some cycads have tuberous roots that look like potatoes. Scientists have

found cycads that are more than 1,000 years old. Most cycads bear a *strobilus* (large cone) that contains seeds. The strobili grow in an upright position at the centre of the leaf clusters of the plants. When the seeds mature, they fall to the ground from the shrivelled strobili.

Cycads are ancient plants that existed in the *Mesozoic Era*, from 240 to 63 million years ago. They are the last survivors of a once widespread group. They have a scattered distribution. The largest number of species are found in the Americas (including Florida). Australia and South Africa also have a wide variety of species. Cycads are grown as ornamental plants. Some species are in danger of extinction from excessive collecting.

Scientific classification. Cycads are cone-bearing plants of the order Cycadales. There are three families, Cycadaceae, *Strangeriaceae*, and *Zamiaceae*.

See also *Conifer*; *Gymnosperm*; *Seed*.

Cyclamen is the name of a group of attractive plants that grow wild in the Mediterranean region of Europe. Cyclamens are found in woods and rocky areas with bushes. There are 17 species. Cyclamens are cultivated outdoors in areas where the climate permits or indoors in pots. The plant grows from a *tuber* (underground stem). The leaves are heart- or bean-shaped and have long *petioles* (leafstalks). The flowers are white, rose, or purple and have no fragrance. They measure up to 6.5 centimetres long.

Cyclamens are cultivated from seed and grow best at temperatures from 10° to 16° C in rich, well-drained soil. Some species flower in the spring, and others bloom in the summer or autumn. Cyclamen plants cultivated indoors or in greenhouses may flower in the winter.

Scientific classification. Cyclamens belong to the primrose family, *Primulaceae*. They make up the genus *Cyclamen*.

Cycle. See *Biorhythm*; *Business cycle*; *Electric current*; *Petrol engine (Cycle)*; *Life cycle*; *Water (Nature's water cycle)*.

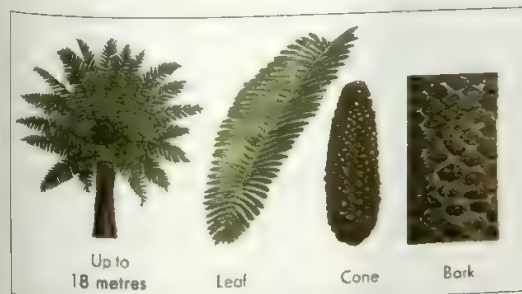
Cycling, or bicycle racing, is one of the most popular sports in the world. Cycling is especially popular in Europe where millions of fans follow the feats of great cyclists. Cycling has been an event in the Olympic Games since the modern games originated in 1896.

There are three chief kinds of cycling—*track races*, *road races*, and *motocross races*. Each kind requires a distinct type of bicycle.

Track races are held on oval tracks called *velodromes*. On most cycling tracks, both ends of the track slope inward at a steep angle. Velodromes may be located indoors or outside. Most championship events take place outdoors on tracks ranging from 250 to 500 metres. Indoor tracks range from 185 to 200 metres.

Championship events are held for individuals and for teams of two or four cyclists. These races can be individual *sprints* (short races) as short as 800 metres or team races 100 kilometres long. Some races are *time trials*, in which racers are timed over a set distance. A *pursuit* is a special kind of time trial that starts with two individuals or teams at opposite sides of the track. The winner is the individual or team that finishes the course first or passes an opponent before the race ends.

A track bicycle has no brakes and only one gear. The cyclist slows down or stops the bike by pushing back on the pedals. The cyclist may also press a gloved hand against the front tyre to stop.



Up to
18 metres

Leaf

Cone

Bark

The cycad plant bears its seeds in cones.



Road races are held outdoors between towns or around a course for a number of laps. Thousands of cyclists may race.

Road races are the original, and most popular, forms of cycling. Hundreds of cyclists may start a race. They cycle over a course between two towns, or around a specific route for a set number of laps.

The most popular road race is the annual Tour de France in which more than 100 contestants race through Europe. The Tour lasts about 24 days and covers about 4,000 kilometres. The distance is divided into sections called *stages*. Cyclists are timed in each stage. The cyclist who completes all the stages in the lowest total time is the winner.

The bicycles used in road races have frames made of special lightweight alloy tubing. They have brakes and handmade narrow tyres. These bicycles have a gear system that includes a *dérailleur*, a mechanism that shifts the bicycle chain from one gear to another.

Bicycle motocross races became popular in the 1970s, especially among young people. The races are often called *BMX* (*bicycle moto-cross*). They are held on dirt tracks less than 400 metres long. The tracks have many bumps and sharp turns. The cyclists ride bicycles that have small wheels and wide tyres to help prevent

them from slipping in the turns. Bicycle motocross racers wear hard helmets and padded clothing for protection against falls, which occur frequently.

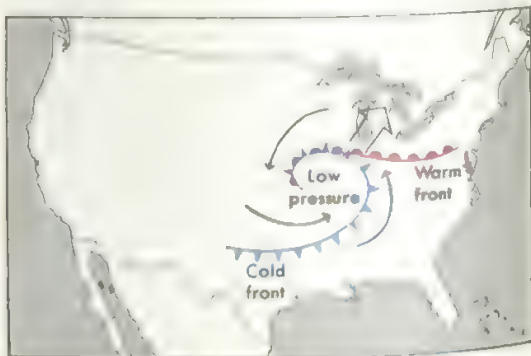
See also **Bicycle**; **Olympic Games** (table: **Cycling**).

Cyclone is a low-pressure area in the atmosphere in which winds spiral inward. A cyclone may cover an area half as large as the entire United States. A special, intense kind of cyclone from about 90 to 2,400 metres across is a *tornado*.

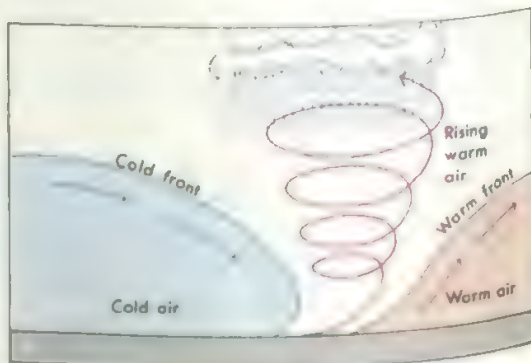
All cyclones have two characteristics: (1) the atmospheric pressure is lowest at the centre, and (2) the winds spiral in toward the centre. In the Northern Hemisphere, the winds blow counterclockwise toward the centre. In the Southern Hemisphere, they blow inward in a clockwise direction.

Some parts of the world have so many cyclones that their average atmospheric pressure is below that of the rest of the world. For example, in the *Aleutian low* in the North Pacific Ocean and the *Icelandic low* of the North Atlantic, the pressure is low most of the winter. Such regions may be called *semipermanent* low-pressure centres or *centres of action*.

Storms usually occur with cyclones. Falling atmospheric pressure generally indicates that bad weather is



The winds of a cyclone spiral in toward a low-pressure centre. In the Northern Hemisphere, they blow counterclockwise as the low-pressure centre moves from southwest to northeast.



A cyclonic storm develops at a low-pressure centre. The heavy cold air along an advancing cold front lifts the lighter, warmer air along a warm front. Clouds form, and rain begins to fall when the water vapour in the warm air condenses.

coming. But sometimes cyclones do not bring bad weather, because the kind of air also has much to do with the weather. For example, if a cyclone forms in dry air, there may not be any clouds.

A **tropical cyclone** is a severe kind of cyclone that occurs over warm ocean waters in the tropics. The cyclones are called *hurricanes* if they form in the West Indies or the eastern Pacific Ocean, and *typhoons* if they form in the western Pacific. These storms may bring winds up 290 kilometres an hour, terrific rains, violent thunder, and lightning. They measure 320 to 480 kilometres across.

Cyclones may be either warm-core or cold-core types. *Warm-core* cyclones are warmer at the centre than near the edges. They are fairly shallow and become weaker in the upper atmosphere. They often occur over especially warm land areas. *Cold-core* cyclones are coldest near the centre and warmer near the edges. These cyclones may be very deep, and are more intense several thousand feet in the air than they are at the surface of the earth.

See also Hurricane; Tornado; Weather; Wind.

Cyclonite. See RDX.

Cyclopedia. See Encyclopedia.

Cyclops, in Greek mythology, was any member of a race of giants with one eye in the middle of the forehead. Three Cyclopes—Arges, Brontes, and Steropes—were sons of the sky god Uranus and the earth goddess Gaea. The three made the thunderbolts carried by Zeus, king of the gods.

The best-known of the Cyclopes was Polyphemus. The epic poem the *Odyssey* describes how the Greek hero Odysseus and his men sailed to an island inhabited by Polyphemus. The Cyclops imprisoned the Greeks and ate six of them. After Odysseus made Polyphemus drunk, he and his surviving men put out the giant's eye with a burning stake and escaped. The blind Polyphemus prayed to his father, the sea god Poseidon, to punish Odysseus. As a result, Odysseus suffered many hardships and delays before reaching his home. Another story tells how Polyphemus killed the Sicilian youth Acis, his rival for the love of the sea nymph Galatea.

Cyclops is a freshwater crustacean. It gets its name from Cyclops, the giant of Greek mythology who had a single eye in the centre of his head. Cyclops are small crustaceans, up to 1 millimetre long. They live in the still waters of lakes and ponds.

The cyclops moves by beating its head antennae down in jerky movements. The female cyclops carries her eggs around on her legs. The eggs can withstand being dried out and remain dormant until they come into contact with water again. Cyclops provide an important source of food for young fish. Related marine types such as *Calanus* are an important source of food for her-
ring.

See also Copepod; Crustacean.

Scientific classification. Cyclops belongs to the class Crustacea, subclass Copepoda, genus *Cyclops*.

Cyclosporin is a drug that fights the rejection of transplanted body tissues and organs. It is produced from cultures of a fungus, *Tolypocladium inflatum*. Jean Borel, a Swiss immunologist, discovered the medicinal properties of cyclosporin in 1972. The drug has proved effective in operations in which the heart, liver, pan-

creas, bone marrow, a kidney, or a lung of one person is transferred to another person. Such use of cyclosporin has lowered the frequency of complications and deaths resulting from these operations.

Cyclosporin works by suppressing the functioning of a person's immune system. The drug is believed to block production of a type of white blood cells called *T-helper cells*. These blood cells attack invading substances and thus cause the body to reject transplanted tissues or organs. In addition to its use during and after transplant operations, cyclosporin has shown promise in the treatment of certain diseases involving the immune system.

Patients may take cyclosporin orally by mixing it in orange juice or milk. The drug also may be injected into the bloodstream. Cyclosporin may produce a number of side-effects. The most serious of these include high blood pressure, reduced kidney function, liver damage, and abnormal growth of hair.

Cyclotron is a machine that accelerates electrically charged atomic particles to high energies. It is a type of *particle accelerator* that makes the particles travel in a circle. Cyclotrons accelerate particles ranging in mass from protons to heavy nuclei. Most reach energies of from 10 million to 50 million electronvolts. A few attain even higher energies.

In a cyclotron, the particles travel in a vacuum chamber located between the poles of a powerful electromagnet. The electromagnet creates a magnetic field that forces the particles to follow a circular path. The vacuum chamber also contains two D-shaped electrodes, called *dees*, that have a gap between them. An alternating electric field is applied across this gap. It acts on the electric charge of the particles and gives them a slight "push" each time they cross the gap. As a result, the particles gradually speed up. The diameter of their path grows in proportion to their speed, and so they spiral outward. When the particles approach the edge of the magnetic field, they are travelling at their maximum speed. They are then directed to a target, or they are extracted from the machine in the form of a particle beam. For a diagram of a cyclotron, see **Particle accelerator**.

The cyclotron was invented in 1930 by the American physicist Ernest O. Lawrence. Lawrence received the 1939 Nobel Prize for physics for his achievement. The cyclotron was originally developed for use in studying nuclear structure, but today it has many functions. Some of the cyclotrons built in recent years can accelerate the atomic nuclei of any of the elements that occur naturally in or on the earth.

Cygnets. See Swan.

Cygnus is a constellation in the Northern Hemisphere. Its most prominent feature is the Northern Cross, which is formed by its five brightest stars. The brightest star, Deneb, marks the upper end toward the northeast. The double star Albireo marks the foot toward the southwest.

Cylinder, in geometry, is a solid figure with two identical bases that lie on parallel planes. Each base is bounded by a curved edge, called the *directrix*. The *lateral surface* (side) of a cylinder consists of parallel lines that join corresponding points on each base. When the directrices of a cylinder are circles, the figure is called a *circular cylinder*. A *right circular cylinder* is a circular

cylinder with a lateral surface that is perpendicular to the bases. Cylinders with a lateral surface that is not perpendicular to the bases are called *oblique circular cylinders*.

The *height* (h) of a cylinder is the perpendicular distance between the planes of the bases. The volume (V) of a cylinder can be calculated by multiplying the height by the area (B) enclosed by either of the two bases:

$V = Bh$. If the bases of a cylinder are circles, then $B = \pi r^2$, where r stands for the radius of either of the circles. The formula for the volume of the cylinder can then be written: $V = \pi r^2 h$. π (pi) is about 3.1416.

The area of the lateral surface in a right circular cylinder is equal to the circumference of the base times the height. It can be found using the formula $L = 2\pi rh$. In the formula, L stands for the lateral surface area. The *total surface area* (A) of a right circular cylinder, therefore, can be calculated by adding together the lateral surface area and the areas of the two bases: $A = 2\pi rh + 2\pi r^2$ or $2\pi r(h + r)$.

Cymbal is a brass percussion instrument shaped like a broad-brimmed hat. The centre of a cymbal resembles the crown of a hat. A musician may hold the cymbal by a leather handle attached to the centre or hang the instrument on a stand. A player can produce tones that vary in quality by striking two cymbals together or by striking one cymbal with a mallet. The mallet may be made of metal or wood, and some are covered with felt or yarn.

Cymbals are made in many sizes. Most musicians prefer cymbals that measure from 30 to 55 centimetres in diameter. Cymbals vary in thickness as well as diameter, and no two sound exactly alike. See *Music* (picture: Percussion instruments).

Cymballike objects were found in the ruins of the Indus Valley civilization, which arose in northwestern India and what is now Pakistan in about 2500 B.C. The cymbal was first used by an orchestra in an opera in 1680 in Hamburg, Germany. The Zildjian Company in the United States manufactures the most widely used cymbals in the world. The company has been making cymbals since 1623. The company originated from Turkey. Zildjian is the Turkish word for cymbalsmith.

Cymbeline (? -A.D. 43?), also called Cunobelinus, was a king of the Catuvellauni, who were the most powerful tribe of southern Britain during the period before the Roman invasion in A.D. 43. He became king in about A.D. 10. Cymbeline set up a new capital at Camulodunum (now Colchester), minted his own coinage, and encouraged the entry of Roman traders into Britain. His sons Caratacus and Togodumnus led the resistance of the Catuvellauni when Roman Emperor Claudius invaded Britain. See also *Caratacus*.

Cynic philosophy was established in the 300's B.C. by Antisthenes, a disciple of the Greek philosopher Socrates. He took as his starting point the doctrine of his

great teacher that virtue rather than pleasure is the chief end of life, and constitutes true happiness. He argued that the wise person is the one who looks with contempt on all the ordinary pleasures of life, and lives without regard for riches or honours. Continued happiness, he declared, is not possible if a person has wants and desires which may not be satisfied. A person is bound by no obligations to society, state, or family, because these things give rise to desires that cannot be satisfied.

Among the enthusiastic followers of Antisthenes was Diogenes, who carried the principles of the Cynics to an extreme. It is said that he lived on the coarsest bread and slept at night in a tub. Zeno of Citium, a Cynic of the late 300's and early 200's B.C., founded Stoic philosophy (see *Stoic philosophy*).

Some authorities say that the name *cynic* refers to *Cynosarges*, the name of the building in Athens where the Cynics first met. Others say that the name comes from the Greek word for dog, and refers to the rude manners of the Cynics. In ordinary speech, a person who sneers at the idea that goodness exists in human nature is often called a *cynic*.

See also *Diogenes*; *Zeno of Citium*.

Cynodont. See *Mammal* (The evolution of mammals).

Cynon Valley (pop. 63,600) is a local government district in Mid Glamorgan, Wales. It lies north of Cardiff and contains the town of Aberdare and the parishes of Penderfryn and Rhigos. The district includes the valley of the River Cynon and the Clydach Valley. There are coal mines near Mountain Ash and Abercynon. Hirwaun and Cwmbach are centres of light manufacturing industry. The region contains the Brecon Beacons National Park and the Aberdare Country Park. The Clydach Valley includes an attractive woodland area. There are sports facilities at Aberdare and Abercynon.

See also *Glamorgan*.

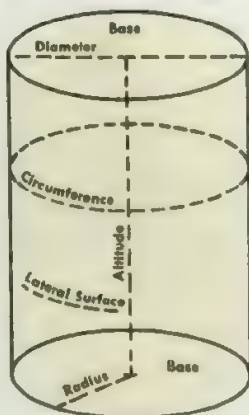
Cypress is any one of a group of evergreen trees and shrubs that grow in Asia, Europe, and North America. Cypressess adapt readily to warm climates, and gardeners often use them as ornamentals. The trees have small, scalelike leaves that grow in dense fan-shaped sprays. Their globe-shaped cones are covered by woody scales that look like small shields. The wood is light brown, durable, and has a strong cedarlike odour.

The *Mediterranean cypress* is a hardy species. The tree is pointed when young, and becomes square topped with age. Several attractive species come from North America, including the *Arizona cypress*, which has green-grey foliage. The North American *bald cypress* is not a true cypress but is related to the sequoia. Some other trees and bushes of the cypress family are known as cedars in North America.

Scientific classification. Cypressess belong to the cypress family, Cupressaceae. The Mediterranean cypress is *Cupressus sempervirens*. The Arizona cypress is *C. arizonica*.

See also *Bald cypress*; *Cedar*; *Conifer*.

Cyprus is an island country in the northeast corner of the Mediterranean Sea. It lies about 64 kilometres south of Turkey and 100 kilometres west of Syria. Geographically, Cyprus is part of Asia. But its people live much like southern Europeans and have a relatively high standard of living. Cyprus is a scenic country noted for its hilltop castles, old churches, beaches, and rugged mountains.



Cyprus



About four-fifths of the people in Cyprus are of Greek origin, and most of the rest are of Turkish origin. Nearly all of the people regard themselves as Greeks or Turks rather than as Cypriot nationals. Conflicts between the two groups have caused problems in Cyprus. Problems have also been caused by the interference of other countries in Cyprus's affairs. In 1974, Turkish troops invaded the island. The Turkish government claimed the troops were sent to support the Turkish Cypriots. The Turks captured a large part of northeastern Cyprus, and thousands of Greek Cypriots fled to the southwestern part of the country. Today, most of the Greeks live in southwest Cyprus, and most of the Turks live in northeast Cyprus.

Cyprus became independent in 1960, after being ruled by the United Kingdom since 1878. Its official name is *Kypriaki Dimokratia* in Greek and *Kıbrıs Cumhuriyeti* in Turkish. Both names mean Republic of Cyprus. Nicosia is the capital and largest city. Most of Nicosia lies in the Greek area, but part of it is located in the Turkish area (see Nicosia).

Government. Cyprus is a republic. According to Cyprus's 1960 Constitution, the president serves as head of state and government. The president must be a Greek Cypriot, elected by Greek Cypriots. The vice president must be a Turkish Cypriot, elected by Turkish Cypriots. The Constitution also provides for a division of power between Greek and Turkish Cypriots in the legislature and in other government institutions.

The Turkish invasion in 1974 caused a split in the country's government. Following the invasion, the Turks established a separate government, but the Cypriot government continued to exist under Greek Cypriot control. See the *History* section of this article for details on the government split.

People. Many people in the cities of Cyprus live in large Western-style apartment buildings. Most of the village people live in simple stone or brick houses built around a courtyard. Some older Cypriot men in rural

areas wear richly decorated waistcoats and baggy black trousers called *vrakas*. Some of the women wear long skirts and short blouses called *sarkas*.

About 90 per cent of Cypriot adults can read and write. Children from 6 to 12 years of age must attend school. Cyprus has technical schools and a teacher training academy.

Most Greek Cypriots are Christians and belong to the independent Orthodox Church of Cyprus. Most Turkish Cypriots are Muslims.

Land. Cyprus has great scenic beauty. Both rugged rock formations and golden sandy beaches line its coast. The broad, fertile Mesaoria Plain separates its two mountain ranges, Troodos and Kyrenia. Troodos, in southwestern Cyprus, is the larger range. Parts of this mountain range are thickly forested. Mount Olympus, its highest peak, rises 1,952 metres above sea level. The

Facts in brief about Cyprus

Capital: Nicosia.

Official languages: Greek and Turkish.

Area: 9,251 km². *Greatest distances*—east-west, 206 km; north-south, 121 km.

Elevation: *Highest*—Mount Olympus, 1,952 m above sea level. *Lowest*—sea level.

Population: *Estimated 1996 population*—742,000; density, 79 people per km²; distribution, 56 per cent urban, 44 per cent rural. *1976 census*—612,851. *Estimated 2001 population*—771,000.

Chief products: *Agriculture*—barley, grapefruit, grapes, lemons, olives, oranges, potatoes, wheat. *Manufacturing*—cement, cigarettes, olive oil, shoes, textiles, wines. *Mining*—asbestos, chromium.

National anthem: "Imnos pros tin Eleftherian" ("The Hymn to Liberty").

Flag: The flag is white with a map of Cyprus in copper-yellow (for copper) in the centre above two green crossed olive branches (for peace). See *Flag* (picture: Flags of Asia and the Pacific).

Money: *Currency unit*—Cyprus pound. One pound = 100 cents.



Nicosia is the capital and largest city of Cyprus. The city's skyline, above, shows the Turkish influence on its architecture.

Kyrenia mountain range stretches along the northern coast of Cyprus.

Cyprus has a pleasant, sunny climate throughout the year. Snow falls high in the Troodos Mountains early in the year. Winters are mild in the Mesaoria Plain, but temperatures sometimes go above 38° C there during the summer. Rainfall averages from 30 to 40 centimetres a year on the plain. Parts of the Troodos receive more than 100 centimetres.

Economy. Tourism ranks as an important industry of Cyprus. Many people visit the country to enjoy its scenery, historic sites, and climate. Chief products include cement, cigarettes, olive oil, shoes, textiles, and wines. Farmers grow barley, grapefruit, grapes, lemons, olives, oranges, potatoes, and wheat. The island's chief minerals are asbestos and chromium. In ancient times, Cyprus produced much copper, but the mines are now almost worked out. Cyprus has a good road system but no railway. Limassol and Larnaca are the chief ports. The main airport is at Larnaca.

History. The earliest known people to live in Cyprus date back to about 6000 B.C. Greek settlers arrived there about 1200 B.C., and started city-states similar to those in ancient Greece (see **Greece, Ancient** [The city-state]). Before the time of Christ, the Assyrians, Egyptians, Persians, Greeks, and Romans conquered Cyprus. Saint Paul and Saint Barnabas brought Christianity to the island in A.D. 45. In A.D. 330, Cyprus became a part of the Byzantine Empire. Richard the Lion-Hearted of England captured Cyprus in 1191, but he sold it to a French nobleman. The Ottomans invaded in the 1570's, and ruled until they turned it over to the British in 1878. The British declared the island a crown colony in 1925.

In the 1950's, Greek Cypriots, under the leadership of

Turkish troops invaded Cyprus in 1974, capturing the dark area shown on this map. Greeks control the light-coloured area.



Archbishop Makarios, started a campaign for *enosis* (union with Greece). A Greek Cypriot secret organization called *EOKA* started guerrilla attacks on the British. The United Kingdom (UK) declared a state of emergency on the island in 1955, and in 1956 exiled Makarios to the Seychelles Islands in the Indian Ocean. Greece and Turkey met in Zurich, Switzerland, in 1959, and agreed that Cyprus should become an independent state. The UK accepted the Zurich agreement. Cyprus became independent on Aug. 16, 1960, under a Constitution written by the UK, Greece, and Turkey and agreed upon by the leaders of the Greek and Turkish Cypriots. The UK, Greece, and Turkey signed an agreement that guaranteed Cyprus' independence. The UK kept control of two military base areas along the southern coast, at Akrotiri and Dhekelia.

Archbishop Makarios became president of the new state. In 1963, Makarios suggested 13 amendments to the Constitution, arguing that they would result in better administration of the country. Turkey and the Turkish Cypriot leaders opposed the changes, arguing that the changes would eliminate many of the Turkish Cypriots' rights and safeguards. Fighting broke out between Greek and Turkish Cypriots. In 1964, the United Nations sent a peacekeeping force to Cyprus while a solution to the conflict was being worked out.

In 1967, another clash between the two groups caused a new crisis. Between 1967 and 1974, Greek and Turkish Cypriots held talks in an effort to reach agreement on the Constitution. Progress was made, but disagreements remained.

Makarios was reelected president in 1968 and 1973. In July 1974, Cypriot national guard forces led by Greek officers overthrew Makarios, who then fled from Cyprus. Nikos Sampson, a newspaper publisher, became president. But he resigned after a week, and Glafcos Clerides, president of the Cypriot House of Representatives, took over the presidential duties.

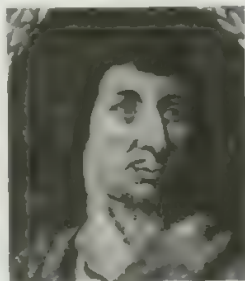
After the overthrow of Makarios, Turkey invaded Cyprus. Widespread fighting occurred between the Turks and Greek Cypriots, and the Turks captured large amounts of territory in northeastern Cyprus. Thousands of Greek Cypriots fled to southwestern Cyprus. Cease-fire negotiations ended the fighting in August. Makarios returned to Cyprus as president late in 1974. Makarios died in 1977, and Spyros Kyprianou, president of the Cypriot House of Representatives, succeeded him. Kyprianou remained president until 1988, when George Vassiliou was elected president. In 1993, Clerides was elected president. But Turkey and the Turkish Cypriots have refused to recognize the Cypriot government.

Since 1974, strong disagreements over control of the country have remained. In 1975, Turkey and Turkish Cypriot leaders declared the northeastern territory captured by the Turks an *autonomous* (self-governing) region called the Turkish Cypriot Federated State. In 1983, the Turkish Cypriots declared the territory an independent nation called the Turkish Republic of Northern Cyprus. However, the United Nations and all countries except Turkey recognize Cyprus as a single nation under the authority of the Greek Cypriot government in the southwest.

See also **Makarios III; United Nations** (Conflict on Cyprus).

Cyrano de Bergerac, Savinien de (1619-1655) was a French author and soldier. He was also known for his skill in sword fighting and for his long nose. Edmond Rostand's famous play *Cyrano de Bergerac* (1897) contains a somewhat fanciful account of Cyrano's life.

Cyrano wrote a comedy *The Ridiculous Pedant* (1653) and a tragedy *The Death of Agrippina* (1654). But his most famous books are two science-fiction works published after his death. They are *The Other World, or the States and Empires of the Moon* (1657), and *The States and Empires of the Sun* (1662). A free thinker, he questioned traditional religious beliefs. He also said matter is made up of atoms.



Cyrano de Bergerac

Cyrano was born in Périgord. Twice wounded in battle, he left military life in 1642 to study science and literature in Paris.

Cyril of Alexandria, Saint (378?-444), was the most outstanding Christian theologian of the early 400's. Cyril formulated what became known as the orthodox doctrine of the Incarnation. This doctrine deals with Jesus as both divine and human. For Cyril, salvation depended upon the proper understanding of how God made Himself human in the person of Jesus.

Cyril was born in Alexandria, Egypt. Little is known of his early life. In 412, Cyril succeeded his uncle, Archbishop Theophilus, in the *see* (bishop's seat) of Alexandria. Cyril attacked Jews, Christian heretics, and pagans, and had the Jews expelled from Alexandria.

In 429, Cyril attacked Nestorius, bishop of Constantinople, for denying that the Virgin Mary was the mother of God. He believed Nestorius was denying that Jesus was both human and divine. In 431, with the support of Pope Saint Celestine I, Cyril persuaded the Council of Ephesus to condemn Nestorius and to accept Cyril's interpretation of the doctrine of Jesus (see **Nestorian Christians**). His feast day is February 9.

Cyrillic alphabet. See **Alphabet** (Other systems of writing); **Russian language**.

Cyrus the Great (? -530 B.C.) founded the Persian Empire about 550 B.C. He extended this empire to include most of southwestern Asia.

Cyrus was born into a noble Persian family, the Achaemenids. In 559 B.C., he became ruler of Anshan, a part of the Median Empire. About 550 B.C., Cyrus overthrew King Astyages of Media and made the Median Empire the centre of what became the Persian Empire. Cyrus seized control of western Asia Minor (now western Turkey) after defeating King Croesus of Lydia about 545 B.C. and then overcoming the Greek cities along the coast of Asia Minor. In 539 B.C., he conquered Babylonia and took control of much of the Middle East.

Cyrus respected local customs and religions in his empire. He freed the Jews from captivity in Babylonia and permitted them to rebuild their temple at Jerusalem in Palestine. Cyrus died in a battle in central Asia.

See also **Persia, Ancient** (The Achaemenid Empire).

Cyst is an abnormal sac in the body that contains fluid and has no outside opening. Cysts of the skin occur more often than others. These usually form when the opening of an oil gland or *hair follicle* (baglike structure that surrounds a hair) becomes blocked. Some cysts form around a foreign substance that gets into the body. Others form around blood, after an injury. A cyst that forms in the salivary gland under the tongue is called a *ranula*. Cysts of internal organs are usually caused by abnormal development of the organ. Cysts are removed by surgery. See also **Wen**.

Cystic fibrosis, also called **CF** or *mucoviscidosis*, is a hereditary disease in which the mucous glands produce abnormally thick, sticky secretions, and the sweat glands secrete unusually salty sweat. The lungs and the digestive system suffer progressive damage over the years. Unknown in Africa, the disease is almost entirely confined to families of European or Middle Eastern origin.

In 1989, researchers identified the abnormal gene that causes cystic fibrosis. This gene is located on *chromosome 7*, one of the 23 pairs of chromosomes in human cells. A person who has two **CF** genes on this pair has the disease. People who carry one normal gene and one **CF** gene do not have the disease themselves. They are called **carriers**. A child of two carriers has a one-in-four chance of inheriting cystic fibrosis.

Patients with cystic fibrosis usually fail to gain weight, and suffer persistent cough and chest infections. Some 10 per cent of newborn babies with **CF** develop a blockage of the intestine (called *meconium ileus*) which requires urgent surgery. Doctors can diagnose the disease by the *sweat test*, which tests for excess salt in sweat.

In **CF** patients, nutrition suffers because mucus blocks the pancreatic ducts, preventing the free flow of the digestive enzymes needed to break down food in the intestine. In the lungs, the airways become clogged and unduly prone to infection.

At one time most **CF** victims died in infancy. Today there is a 75 per cent chance of survival into adulthood. Modern treatment aims to keep the airways as clear as possible with daily physiotherapy. Chest infections are prevented or treated to minimize lung damage. Since the mid-1980's, heart-lung transplantation has been offered to some older children and young adults with badly affected lungs.

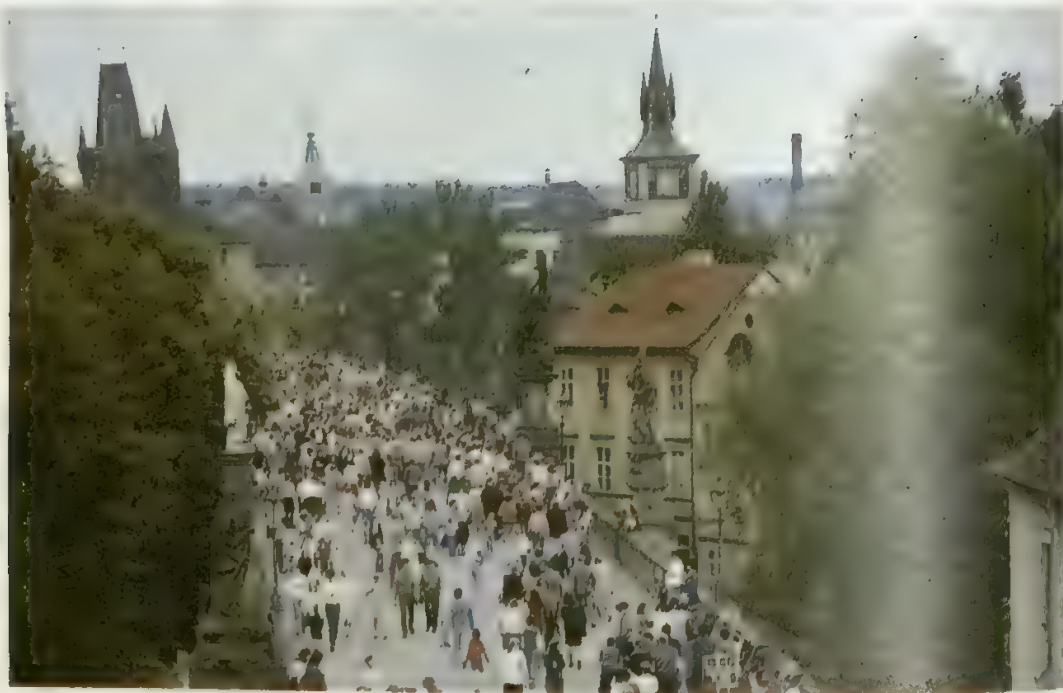
A drug called **DNase** is being tested for treatment of **CF**. The drug is genetically engineered from an enzyme that occurs naturally in the human body. **DNase** helps break up the mucus in the airways.

Cystitis. See **Bladder**.

Cytology is the study of the internal structure and organization of cells. Microscopic studies of the structure of the cell provided an explanation of cell division, and served as a foundation for genetics (see **Genetics**).

These studies also showed that each structure has some function, and that each cell activity is related to changes in chemicals that make up the cell. *Cytochemistry* is the study of chemical activities inside cells. See also **Cell**.

Cytoplasm. See **Cell** (Inside a living cell); **Protoplasm**. **Czar**, also spelled *tsar*, was the title used by the emperors of Russia. **Czar** comes from *Caesar*, the name used by the emperors of Rome. The first Russian ruler to adopt the title was Ivan the Terrible, in 1547. The last one was Nicholas II (1868-1918). See also **Caesar**; **Kaiser**.



Prague, the capital and largest city of the Czech Republic, is one of the most beautiful cities in central Europe. The Charles Bridge, *above*, is a major tourist attraction.

Czech Republic

Czech Republic is a country in central Europe that became independent on Jan. 1, 1993. It is bordered by Poland to the north, Slovakia to the east, Austria to the south, and Germany to the west. Prague is the capital and largest city. From 1918 until Dec. 31, 1992, the area that is now the Czech Republic was united with Slovakia in a larger nation called Czechoslovakia.

Most of the people in the Czech Republic belong to a Slavic group called *Czechs*. Two regions—Bohemia in the west and Moravia in the east—make up most of the republic. The country also includes a small part of a region called Silesia, which extends from the northern section of the Czech Republic mostly into Poland.

The area that is now the Czech Republic has been an industrial centre since the 1800's. From 1948 until 1989, when Communists ruled Czechoslovakia, the people in the region had one of the highest standards of living in Communist central and eastern Europe. However, their prosperity declined in the 1980's, and dissatisfaction with the Communist government grew. In 1989, following mass protests, the country's top Communist leaders resigned. Non-Communists took over the government.

Soon after the Communists left office, tensions began to build between Czechoslovakia's two main ethnic groups, the Czechs and the Slovaks. In mid-1992, Czech and Slovak leaders decided to split Czechoslovakia into two nations, one for Czechs and one for Slovaks. On Jan. 1, 1993, the Czech Republic and Slovakia were formed to replace Czechoslovakia.

This article deals with the area that is now the Czech Republic from its early history to the present. For more information on Czechoslovakia, see the *World Book* article on Czechoslovakia.

Government

National government. The Czech Republic is a parliamentary democracy. A two-house Parliament makes the country's laws. The 81 members of the smaller house, called the Senate, serve six-year terms. Voters elect one-third of the senators every two years. The 200 members of the larger house, called the Chamber of Deputies, are elected to four-year terms. The Parliament

Facts in brief about the Czech Republic

Capital: Prague.

Official language: Czech.

Official name: Česká Republika (Czech Republic).

Area: 78,864 km². *Greatest distances*—east-west, 491 km; north-south, 282 km.

Elevation: *Highest*—Sněžka, 1,602 m above sea level. *Lowest*—115 m along the Elbe River near the German border.

Population: *Estimated 1996 population*—10,464,000, density, 133 people per km². *1980 census*—10,291,927. *Estimated 2001 population*—10,690,000.

Chief products: *Agriculture*—barley, cattle, hops, maize, oats, pigs, potatoes, poultry, rapeseed, rye, sheep, sugar beet, wheat. *Manufacturing*—footwear, glass, iron and steel, textiles. *Mining*—coal.

National anthem: "Kde domov můj?" ("Where Is My Home?")

Money: *Currency unit*—Czech koruna. One koruna = 100 haléřů.

elects a president, who serves as head of state. The president appoints a prime minister, who heads the government and oversees its day-to-day operations. The prime minister names a cabinet to help carry out the executive functions of government.

Local government. The Czech Republic is divided into seven regions, excluding Prague, which is a separate administrative unit. Each region is governed by an elected council. Cities, towns, and villages also have their own local governments.

Politics. The Czech Republic has many political parties. The Civic Democratic Party and the Christian Democratic Union, two moderate non-Communist parties, form a coalition in the government. Together, they are the strongest parties. The Left Bloc, a group that includes former Communists, is the next most important party. Several smaller parties also hold seats in the Chamber of Deputies. All Czech citizens 18 years of age and older may vote.

Courts. The Supreme Court is the Czech Republic's highest court. The Czech Republic also has a constitutional court and high, regional, and district courts.

Armed services. Men are required to serve for one year in the armed services of the Czech Republic after reaching the age of 18. Women serve in the military on a voluntary basis.

People

Population. For the Czech Republic's total population, see the *Facts in brief* table with this article. About 80 per cent of the people are Czechs and about 15 per cent are Moravians. Slovaks make up the largest minority group. Small numbers of Germans, Gypsies, Hungarians, and Poles also live in the Czech Republic.

Before World War II (1939-1945), Czechoslovakia had a large Jewish population. But almost all the Jews were killed by Nazis during the war. Today, between 15,000 and 18,000 Jews live in the Czech Republic. Most of the Jews make their homes in Prague, which has a well-preserved Jewish synagogue and cemetery.

Ancestry. The Czechs are descendants of Slavic tribes who settled in the region by about A.D. 500. Bohemia gets its name from the Boii, a Celtic tribe that probably lived in the region in about the 400's B.C. There have been large German settlements in what is now the Czech Republic for much of the region's history.

Language. The official language of the Czech Republic is Czech. Moravians speak a form of Czech that is slightly different from that spoken in Bohemia. Slovaks speak Slovak, a language closely related to Czech. Gypsies speak Romany, which belongs to the Indo-Iranian group of languages. Other minority groups speak their own languages at home but generally also speak Czech.

Way of life

City life. Most of the people in the Czech Republic live in towns and cities. Prague, with a population of more than 1 million, is the largest city. Other cities with more than 150,000 people are Brno, Ostrava, and Plzeň.

The Czech Republic has a severe housing shortage. Most people in urban areas live in blocks of flats, many of which are poor quality high-rises built during the Communist era.

Air pollution is a health threat in the Czech Republic,

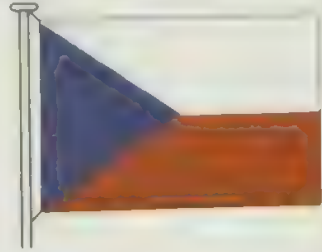
especially in the cities. Alcoholism, crime, and drug abuse are also serious problems.

The Czech government is working to move the country from a Communist state-controlled economy to one based on private enterprise. Despite disruptions caused by the shift, the people of the Czech Republic still have one of the highest standards of living in post-Communist central and eastern Europe. Most households have cars, refrigerators, televisions, and washing machines. Many city families also have country cottages.

Rural life. People in rural areas usually work in agriculture or travel to cities or nearby factories to work. Rural families often live in single-family homes.

Food and drink. The Czech diet is close to that of Germany. Pork is a popular dish, as are sliced, boiled dumplings and pickled cabbage. Carp with potato salad is a traditional Christmas menu. Apple strudel is a favourite dessert. World-famous Czech beer is the main alcoholic beverage consumed in the Czech Republic. Several fine wines are made in Moravia.

Recreation. Favourite forms of recreation in the Czech Republic include attending and playing in football matches and other sporting events, and watching films and television. Many people gather in pubs to chat, play games, and drink. Outdoor activities, including gardening, hiking, and winter sports such as skiing and skating, are also popular.



Symbols of the Czech Republic include a flag adopted in 1993. It is the same flag that Czechoslovakia used. The coat of arms features a white lion with a double tail on a red field. The Holy Roman emperor granted it to Bohemia in the 1100's.



The Czech Republic is in central Europe. It borders four countries including Slovakia, its former partner in Czechoslovakia.

Religion. The Communist rulers of Czechoslovakia tried to keep people from practising religion. But Czechoslovakia's new government granted the people full religious freedom in 1990. About 40 per cent of the people are Roman Catholics. Other active churches include the Orthodox Church and Protestant denominations such as the Czech Brethren and the Czechoslovak Church. The country's Jewish population is working to revive Jewish culture and customs.

Education. Czech law requires children to attend nine years of elementary school. A student may then attend a vocational or technical secondary school, a teacher training institute, or a general education school.

Charles University in Prague is one of the oldest universities in Europe. It was founded in 1348. Other well-established universities are in Brno, Olomouc, and Opava. Most schools and all universities are state-owned.

Arts. The composers Antonín Dvořák and Bedřich Smetana, who wrote their major works in the late 1800's, are considered the founders of the Czech national school of music. Composer Leoš Janáček created operas in the early 1900's that show his interest in Moravian folk music. Today, many people in the Czech Republic enjoy listening to country, jazz, and rock music.

The first major works of literature in Czech were written in the 1300's. Czech literature flowered during an awakening of national identity that began in the late 1700's and continued into the late 1800's and early 1900's. Outstanding authors from the later period include Karel Čapek; Jaroslav Hašek; and Franz Kafka, who wrote in German.

Czechoslovakia's Communist government attempted to limit artistic expression. However, many Czech artists, filmmakers, and writers resisted political control. Miloš Forman, Jiří Menzel, and other Czech *New Wave* filmmakers achieved worldwide acclaim during the 1960's for films that criticized social and political conditions. A large number of Czech writers became known outside Czechoslovakia for their works. These writers include the novelist Milan Kundera; the playwright Václav Havel, who later became president of Czechoslovakia and of the Czech Republic; and the poet Jaroslav Seifert, who won the Nobel Prize for literature in 1984. The non-Communist government removed restrictions on art in 1990.

Architecture in the Czech Republic includes many castles and palaces. Many of the castles were built in the elaborate Baroque style. There are many regional styles of folk architecture, as seen in the ornamental details on wooden cottages and churches.

Land and climate

The Czech Republic consists of five main geographic regions: (1) the Bohemian Mountains; (2) the Sudeten Mountains; (3) the Bohemian Basin; (4) the Bohemian-Moravian Highlands; and (5) the Moravian Lowlands.

The Bohemian Mountains are a series of mountain ranges in the western part of the Czech Republic. These ranges include the Ore Mountains in the northwest and the Bohemian Forest in the west and southwest. This region, which rises more than 750 metres above sea level, is known for its ski slopes and *spas* (health resorts). Many people visit the spas at Karlovy Vary (also called

Karlsbad) and Mariánské Lázně (also called Marienbad) to drink waters from the mineral springs there or bathe in them. Coal mining in the Ore Mountains and industrial pollution have damaged the region's environment. The Bohemian Forest is an important source of lumber and wood products.

The Sudeten Mountains form much of the Czech Republic's northern border. The *Krkonoše* (Giant) Mountains of the Sudeten system are home to one of the country's largest nature reserves. But acid rain and other kinds of pollution threaten the animal and plant life there.

The Bohemian Basin lies in north-central Bohemia. This region of low plains and rolling hills has much fertile farmland. Prague and Hradec Králové are among the region's industrial centres. Several major rivers, including the Elbe, the Ohře, and the Vltava, flow through the basin.

The Bohemian-Moravian Highlands cover much of the central part of the Czech Republic. High plains, plateaus, and low hills make up this largely agricultural region. Plzeň, the largest city in the area, is a major manufacturing centre noted for carmaking and beer brewing. The city's breweries produce a famous pale beer called Pilsner. The Sázava, the Vltava, and several smaller rivers drain the highlands.

The Moravian Lowlands occupy the southeastern part of the country. Farmers grow a variety of crops in the fertile valley of the Morava River. Many farmers also raise cattle there. The city of Ostrava is an industrial and mining centre. Important coal fields lie nearby. Besides the Morava, the Oder and a number of other rivers flow through the lowlands.

Climate. The Czech Republic has warm summers and cold winters. Temperatures vary greatly by elevation. They range from an average of -5°C in winter to 20°C in summer. Annual *precipitation* (rain, melted snow, and other forms of moisture) ranges from 45 to 103 centimetres.

Economy

After the Communists came to power in Czechoslovakia in 1948, they began managing all aspects of the



The Sudeten Mountains form most of the northern border of the Czech Republic. The natural beauty of the region draws many hikers, mountain climbers, and other outdoor enthusiasts.

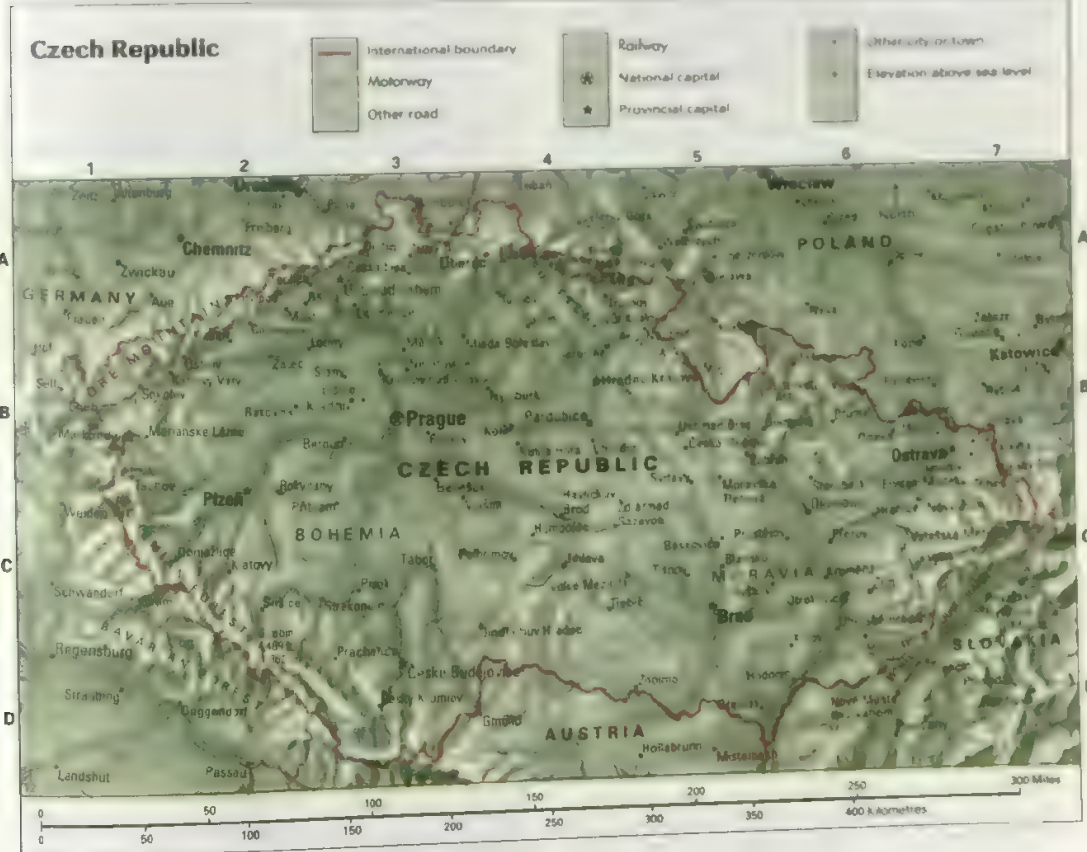
economy. They put all factories and almost all farms under state control. They changed the economy's focus from light industry, such as glass and textiles, to heavy industry, such as machinery and steel. The economy thrived until the 1960's, when poor planning, labour shortages, and other problems caused it to decline. After the Communist government resigned in 1989, Czechoslovakia's new leaders moved quickly to create a free-enterprise economy, in which businesses could operate without extensive government control.

Service industries. About 45 per cent of the workers of the Czech Republic hold jobs in service industries. There are many new, privately owned insurance and

property firms, medical and other professional services, repair shops, retail stores, hotels and travel agencies.

Manufacturing and mining. Manufacturing employs about 40 per cent of the labour force of the Czech Republic. Although heavy industry is still important today, light industries such as footwear, glass, and textiles are reemerging as important producers for export. The main manufacturing centres are Brno, Hradec Králové, Ostrava, Plzeň, Prague, and Ústí nad Labem.

The Czech Republic has large deposits of coal, especially brown coal. The Ore Mountains contain large deposits of uranium and small amounts of antimony, mercury, and tin.



Czech Republic map index

Cities and towns

Beroun	23,790	3	Hodonín	26,584	6	Mariánské Lázně (Vrnoučice)	18,510	1
Blansko	19,962	5	Hradec Králové	101,000	6	Mělník	19,494	3
Bohumín	25,068	7	Hranice	19,087	7	Mladá Boleslav	48,325	4
Břeclav	23,495	5	Jablonec	45,459	4	Most	71,000	4
Brno	391,979	3	Jihlava	53,074	4	Náchod	20,242	5
Česká Lípa	33,679	5	Jindřichův Hradec	21,713	4	Nový Jičín	107,000	6
Česká Budejovice	99,000	3	Kadov	18,557	4	Olomouc	61,543	6
Český Těšín	24,741	7	Karlovy Vary (Karlsbad)	58,541	2	Opava	33,658	7
Chabarovsk	31,345	8	Karviná	70,000	7	Orlová	331,448	7
Chomutov	58,105	4	Kladno	73,000	3	Ostrava	19,391	6
Chrudim	21,386	4	Kolín	22,774	2	Pardubice	19,628	4
Debín	55,284	3	Krnoh	26,055	6	Písek	29,068	3
Frýdek-Místek	66,000	7	Liberec	104,000	4	Plzeň	175,049	2
Havířov	92,000	8	Lidice	25,176	4	Prague (Praha)	1,215,656	3
Havlíčkův Brod	25,182	4	Litoměřice	21,452	2	Přerov	50,355	6
Hlučín	23,056	7	Lhynov	25,142	2			

Sources: 1990 official estimates for largest cities, 1985 official estimates

PHBram	39,165	3
Prostějov	51,081	6
Sokolov	28,646	2
Strakonice	23,639	2
Šumperk	33,101	5
Tábor	53,928	2
Teplice	36,130	4
Třebíč	44,685	7
Trutnov	30,440	4
Uherské Hradiště	37,329	6
Ústí nad Labem	106,000	3
Valešská Mezivěže	26,598	7
Vsetín	31,074	2
Zlín	22,832	6
Žďár nad Sázavou	26,050	4
Znojmo	37,983	5

Physical features

Berounka (river)	B	2
Bohemian Forest	C	2
Boubín (peak)	D	3
Elbe (river)	B	2
Jeseník Mountains	B	6
Krkonoše Mountains	A	4
Lipenská Reservoir	D	3
Lubnice (river)	C	6
Morava (river)	C	6
Mže (river)	B	2
Oder (river)	C	6
Ohře (river)	B	2
Ore Mountains	B	1
Sázava (river)	C	4
Sněžka (peak)	A	4
Sudeten Mountains	A	4
Svrlava (river)	C	5
Vltava (river)	C	3



Steel manufacturing plants employ many of the Czech Republic's industrial workers. The cities of Kladno and Ostrava are leading centres of steel production.

Agriculture employs about 10 per cent of the workers of the Czech Republic. About 40 per cent of the country's land is suitable for farming. Major crops are barley, fruit, hops, maize, oats, potatoes and other vegetables, rapeseed, rye, sugar beet, and wheat. Farmers also raise cattle, pigs, poultry, and sheep.

When Communists ruled Czechoslovakia, almost all the farms were either state farms or *collectives*. State farmworkers earned a salary from the government, while collective farmworkers received a share of the farm's profits, some of its products, and a small wage. Legislation was passed in 1991 that began to allow farmland to be returned to private farmers. By the mid-1990's, over half of the farmland was privately owned.

Trade. The Czech Republic's main trading partners are Austria, France, Germany, Hungary, Italy, Poland, Russia, Slovakia, and the United States. Chief exports include cars, coal, footwear, iron and steel, and machinery. The country depends heavily on imports of natural gas and petroleum. Other major imports include iron ore, other ores, and cars.

Transportation and communication. The Czech Republic has a well-developed system of roads and railways. There are about 56,000 kilometres of highways and 9,500 kilometres of railways. Prague has an underground railway system and an international airport.

There are about 30 daily newspapers and some 1,800 other journals, newspapers, and magazines in the Czech Republic. Radio and television stations operate under both private and state ownership. Foreign news broadcasts, such as Cable News Network, are also available.

History

Early days. Celtic tribes probably lived in what is now the Czech Republic in about the 400's B.C. Germanic tribes arrived about 10 B.C. Various Slavic tribes, including the ancestors of the present-day Czechs, settled in the region by about A.D. 500. The Slavs were conquered by the Avars in the 500's. The Slavs drove the Avars from the region in the 600's. Several of the Slavic tribes united to create their own state in the 800's. The state formed the core of the Greater Moravian Empire,

which eventually included Bohemia, southern Poland, Slovakia, and parts of western Hungary. Hungarian tribes conquered the Greater Moravian Empire in 907.

The rise of Bohemia began during the 900's. The Přemyslid dynasty ruled Bohemia for almost 400 years. Under its rule, Bohemia expanded its territory and came under the protection of the Holy Roman Empire, a German-based empire that also included Austria and parts of Belgium, Italy, and the Netherlands. In 1212, Holy Roman Emperor Frederick II made Bohemia a semi-independent kingdom within the empire. Many German craftworkers and merchants settled in Bohemia in the 1200's, contributing to the region's prosperity.

Bohemia's political and economic power continued to grow in the 1300's. Prague flourished under Charles IV, who became king of Bohemia in 1346 and ruled as Holy Roman emperor from 1347. In 1348, Charles founded Charles University, which was the first university in central Europe, in Prague. Charles also brought foreign artists to Prague to make the city a major European cultural centre.

The death of a priest named John Hus in 1415 triggered a series of religious wars in Bohemia. Hus led a movement to reform the Roman Catholic Church and was burned at the stake as a heretic. The wars ended in 1436 with a compromise. In 1458, Hus supporters elected Jiří of Poděbrady, a Protestant, king of Bohemia. Jiří thus became the first Protestant king in Europe. In the late 1400's, most of the Czech nobility became Protestants, and the power of the nobles increased.

Habsburg rule. In 1526, the Austrian Habsburgs (or Hapsburgs), a Catholic family, began ruling Bohemia. Bohemia remained partially independent, though the nobles lost some power. In 1618, a group of Czech Protestant nobles revolted against the Habsburgs. This revolt touched off the Thirty Years' War.



A memorial to John Hus, the religious reformer, stands in Old Town Square in the centre of Prague, the capital of the Czech Republic.

In 1620, the Habsburg armies defeated the nobles in the Battle of White Mountain. Almost all the nobles were killed or forced into exile. Bohemia then lost most of its self-governing powers. The Habsburgs made the people convert to Catholicism. They also forced most Czechs to give up their own language and culture and adopt German.

German culture dominated Bohemia until the late 1700's. At about this time, industries began to develop in Bohemia and Moravia, and many Czech peasants moved to cities. Czech writers and other intellectuals worked to create a greater sense of national identity among Czechs. By the mid-1800's, a movement for self-government had gathered strength. But Austria continued to rule Bohemia and Moravia. In 1867, Austria and Hungary formed a monarchy called Austria-Hungary.

The creation of Czechoslovakia. During World War I (1914-1918), Tomáš Masaryk and other Czech leaders sought support abroad for their idea of an independent state made up of Czechs and Slovaks. At the end of the war, Austria-Hungary collapsed, and Czechoslovakia was created from a part of it. The Czechoslovak Constitution established a democratic republic.

Masaryk served as president of Czechoslovakia from 1918 until 1935, when Eduard Beneš succeeded him. The 1920's and early 1930's were generally a period of political stability and prosperity in Czechoslovakia. However, the Czech-dominated government was less successful in dealing with the country's minority groups. Many Slovaks began calling for broader powers of self-government. The *Sudeten Germans*—Germans living in the Sudetenland, the border regions of western Czechoslovakia—were also dissatisfied with Czech rule.

The Munich Agreement. In 1938, German dictator Adolf Hitler used the dissatisfaction of the Sudeten Germans to pressure Czechoslovakia to give the Sudetenland to Germany. He threatened to declare war on Czechoslovakia if his demand was not met. In an attempt to avoid war, British and French leaders gave in to Hitler's demand. They signed the famous Munich Agreement forcing Czechoslovakia to turn over the Sudetenland to Germany. Later that year, Poland and Hungary claimed parts of Czechoslovakia. In March 1939, a few months before World War II broke out, Germany seized the rest of Czechoslovakia. Slovakia became a separate state under German control, and German troops occupied Bohemia and Moravia. Beneš, who had resigned as president in 1938, established a government-in-exile in London.

The people of Bohemia and Moravia suffered greatly under German occupation. Nazis killed almost all the Jewish population. By 1945, Soviet troops had freed most of Czechoslovakia from the Germans. After World War II ended in 1945, the government-in-exile returned.

Communist rule. Beneš formed a coalition government to lead postwar Czechoslovakia. Leaders of the Communist Party held many important positions in the new government. In national elections in 1946, the Communists won more votes than any other party. In 1948, they caused a crisis that led to the resignation of non-Communist government ministers. The Communists then formed a government dominated by Communists. Beneš soon resigned and was replaced by Communist Party chairman Klement Gottwald.

Czechoslovakia's Communist leaders copied the Soviet model of Communist rule. The Communist Party became the only powerful political party. The government controlled the planning and production of all important goods. It took over nearly all the country's land and forced most farmers to join state farms or collectives. Censorship became widespread. The power of the secret police grew, and Czechoslovakia became one of the Soviet Union's most loyal allies.

The 1960's. During the 1960's, economic performance in Czechoslovakia dropped. In addition, many Slovaks wanted greater recognition of Slovak rights. In 1968, Alexander Dubček became head of the Communist Party. Under Dubček, the government introduced a programme of liberal reforms known as the "Prague spring" or "socialism with a human face." The press was granted greater freedom, and citizens were given a limited role in politics. But leaders of the Soviet Union and other Eastern European nations feared that Dubček's programmes would weaken Communist control in Czechoslovakia. They also feared that people in other Communist countries would demand similar reforms. As a result, troops from the Soviet Union, Bulgaria, East Germany, Hungary, and Poland invaded Czechoslovakia in August 1968. Gustav Husák replaced Dubček as head of the Communist Party in April 1969 and reversed most of the reforms. A small number of *dissidents* (political protesters) continued to oppose the government.

The Velvet Revolution. During the late 1980's, the standard of living in Czechoslovakia fell. Support for the Communist system also declined. The dissident movement grew, inspired by the democratic reforms that were taking place in the Soviet Union under Mikhail Gorbachev. In November 1989, large numbers of Czechs and Slovaks gathered in the streets of Prague to call for an end to Communist rule. Less than a month after the protests began, the Communist government resigned. Non-Communist leaders gained control of the government. The Federal Assembly elected Václav Havel, a non-Communist playwright, to succeed Husák as president. The end of Communist rule occurred so smoothly and peacefully that it became known as the *Velvet Revolution*.

In free elections held in June 1990, Civic Forum—the Czech party that had emerged in 1989 to lead the Velvet Revolution—and its Slovak ally, Public Against Violence, won a majority of seats in the Federal Assembly. The Assembly reelected Havel president in July 1990.

Czechoslovakia's new leaders restored such basic civil liberties as freedom of religion, speech, and the press. New laws were passed to change the legal system, restore property rights, and establish a free-enterprise economy. Czechoslovakia also reestablished friendly relations with Western nations, including the United States.

The breakup of Czechoslovakia. After the non-Communist government took office, Czechs and Slovaks began to disagree over political and economic issues. The disagreements blocked the adoption of a new constitution and slowed economic reform. In mid-1992, Czech and Slovak leaders began to discuss splitting the country into two separate nations. Havel resigned, saying that he did not want to preside over the breakup of Czechoslovakia.

On Jan. 1, 1993, the Czech Republic and Slovakia were created to replace Czechoslovakia. Later in January, the Czech legislature elected Havel president of the Czech Republic.

Related articles in *World Book* include:

Biographies

Beneš, Eduard	Hus, John
Čapek, Karel	Janáček, Leoš
Comenius, John A.	Kafka, Franz
Dvořák, Antonín	Smetana, Bedřich
Havel, Václav	

Cities

Brno	Ostrava
Karlovy Vary	Prague

History

Austria (History)	Thirty Years' War
Czechoslovakia	Warsaw Pact
Habsburg, House of	World War II (The failure of appeasement)
Munich Agreement	

Other related articles

Bohemia	Ruthenia	Slovakia
Elbe River	Silesia	Sudetenland
Moravia		

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VI. History

Questions

- What event in Bohemia touched off the Thirty Years' War?
- What industries were stressed in Czechoslovakia during the Communist era?
- What beverage is the Czech Republic famous for?
- What was the Czech *New Wave*?
- Who were the first and last presidents of Czechoslovakia?
- What changes did Czechoslovakia's new leaders make when they took office in 1989?
- When and how did Communist rule of Czechoslovakia end?
- Who are considered the founders of the Czech national school of music?

Why did troops invade Czechoslovakia in August 1968? What Czech Republic region has especially fertile soil?

Czechoslovakia was a country in central Europe from 1918 until 1992. On Dec. 31, 1992, Czechoslovakia ceased to exist, and the Czech Republic and Slovakia were formed in its place.

Czechoslovakia was home to two closely related Slavic peoples, the Czechs and the Slovaks. Most of the Czechs lived in the western part of the country, in the regions of Bohemia and Moravia. The Slovaks lived primarily in Slovakia, an area in the east.

Czechoslovakia gained independence in 1918, when the Czechs and Slovaks united to form a single nation. Before that, Bohemia, Moravia, and Slovakia had been part of Austria-Hungary.

In 1948, Czechoslovakia became a Communist state. The Communists reorganized the country's economy and government and modelled them on those of the former Soviet Union. In 1968, the government of Czechoslovakia began a reform programme to give the people more freedom. But troops from the Soviet Union and four other European Communist countries—Bulgaria, East Germany, Hungary, and Poland—invaded Czechoslovakia and ended the reform programme.

In the late 1980's, the Soviet Union made reforms toward giving its people more freedom. Czechoslovakia's people also demanded reforms. At first, the government resisted their demands. But in 1989, following large protests by the people, the Czechoslovak Communist Party ended its domination of the government. The country's first free elections since the Communists took power were held in 1990. In 1992, following a reawakening of Slovak nationalism, the Czech and Slovak parts of the federated republic of Czechoslovakia agreed to start the process of becoming two independent countries.



Czechoslovakia was a country in central Europe. Its past is seen in the historic castles and picturesque villages of the region, such as Branov nad Dyji, above.

On Jan. 1, 1993, the Czechs formed the Czech Republic and the Slovaks formed Slovakia to replace Czechoslovakia.

Early history. Prehistoric peoples lived in what is now Czechoslovakia thousands of years ago. To the north and east of the area are the flat plains of what is now Poland and Ukraine where many Slavic peoples lived. But the lowlands of Czechoslovakia were protected by mountains: the Bohemian Mountains in the west, the Sudeten Mountains to the north, and the Western Carpathians to the east. The Bohemian Mountains are a series of ranges that rise to more than 750 metres above sea level. The Sudeten Mountains are higher and more rugged than the Bohemian Mountains. The Western Carpathians consist of a series of mountain ranges that cover most of what is now Slovakia.

Between the mountain ranges are three distinct areas of lowland: the Bohemian Basin, the Moravian Lowlands, and the Danubian Lowlands. The Bohemian Basin is a low-lying area of plains and rolling hills. Numerous rivers and streams originate in the surrounding highlands and flow into the basin. The Moravian Lowlands span the valley of the Morava River. The Danubian Lowlands form the southern boundary of the area.

By about A.D. 500, various Slavic tribes from the north had settled in the three lowland regions. In the A.D. 800's, several of the tribes united to form the Greater Moravian Empire, which covered much of central Europe. The empire lasted until about 900, when the Magyars (Hungarians) conquered the Slavic ancestors of today's Slovaks. The Magyars ruled Slovakia for the next thousand years. The rest of the Greater Moravian Empire broke up into smaller states.

The rise of Bohemia began around A.D. 900. The Přemyslid family ruled the country for about 400 years. Under its rule, Bohemia became a semi-independent kingdom within the Holy Roman Empire. By the 1100's, Bohemia included Moravia and parts of Austria and Poland. In the 1200's, many German craftworkers and merchants settled in Bohemian towns.

Bohemia reached its cultural and political peak under Charles IV, who ruled from 1346 to 1378. Charles was



Bohemian glass was first manufactured in the mid-1500s. Engraved glass, as above, became an important product of the country.

crowned Holy Roman emperor, and Prague became the empire's leading city.

A period of religious wars began in Bohemia after the death of John Hus in 1415. Hus had led a movement for reform in the Roman Catholic Church.

Hus vigorously attacked the papacy. Because of a confused papal election in 1378, two men claimed to be pope. After 1409, a third man claimed the papal throne. During this period, many devout people questioned papal authority. Hus went further, calling the papacy an "institution of Satan." He was burned at the stake as a heretic. His followers, called Hussites, fought loyal Roman Catholics from 1419 until 1434, and reached a compromise in 1436.

Habsburg rule. In 1526, the Habsburg ruler of Austria, Ferdinand I, became king of Bohemia and Hungary. Under the Habsburgs, Bohemia remained semi-independent, though the nobles lost some power.

During the 1500's the Reformation gave birth to Protestantism. Although the Habsburgs were Catholics, many Czechs became Protestants. In 1618, a group of Czech Protestant nobles revolted against Habsburg rule. They elected a Protestant king of Bohemia. The revolt touched off the Thirty Years' War, a series of wars that spread through Europe (see *Thirty Years' War*).

In 1620, the Habsburg armies defeated the nobles in the Battle of White Mountain. Bohemia then lost most of its self-governing powers. Representatives of the Habsburgs began to rule Bohemia's three provinces: Bohemia, Moravia, and Silesia. They forced most Czechs, other than peasants, to adopt the German language and culture, and Catholicism became the state religion.



Three distinct areas make up the region which became Czechoslovakia in 1918.

Prussia, which included land that now lies in Germany, Poland, and Russia, conquered most of Silesia in 1741. But Bohemia, Moravia, and part of Silesia remained under Austrian rule.

Industries were developing in Bohemia and Moravia in the late 1700's. As early as the mid-1500's, the region had been known for its decorative glassware. Bohemian glassmakers were the first to produce engraved glass. As the need for glass grew so the industry expanded, but the work was done by a few craftsmen, working in small factories.

However, by the early 1800's, other industries were developing around the coal deposits of Bohemia and Moravia. Coal, in the form of coke, was needed in the production of iron. Deposits of iron ore in the Western Carpathian region of Slovakia made the growth of an iron industry possible. Many Czech peasants moved to the industrial areas and the growing cities.

By the mid-1800's, these Czech workers had replaced the Germans as the largest population group in the cities and towns of Bohemia and Moravia. At about the same time, many Czechs began to promote a rebirth of the Czech language and culture. The growth of Czech national feeling led to demands for self-government. A similar movement developed in Slovakia, which belonged to the Habsburg Empire as part of Hungary. But Hungarian rulers put down the Slovak movement. In 1867, Austria and Hungary formed a monarchy called Austria-Hungary (see *Austria-Hungary*).

Independence. During World War I (1914-1918), opposition activity increased in Bohemia. The Habsburg government suppressed the activity. Two leading Czech nationalists—Tomáš Masaryk and Eduard Beneš—left the country. In 1916, Masaryk, Beneš, and several other Czech and Slovak leaders formed the Czechoslovak National Council in Paris. The council worked to win foreign support for an independent Czech-Slovak state.

In 1918, the Allies recognized the council as the provisional government of a new nation—Czechoslovakia. That year, Austria-Hungary collapsed, and Czechoslovakia was proclaimed an independent country, made up of Bohemia, Moravia, and Slovakia. In 1919, Ruthenia, a region east of Slovakia, became part of Czechoslovakia. The Czechoslovak Constitution established the country as a democratic republic. Masaryk served as president of Czechoslovakia from 1918 until 1935, when Eduard Beneš succeeded him.

During the 1930's, unrest spread among Czechoslovakia's minority groups. Although Czechs made up only about 50 per cent of the population, they controlled the economy and government. The Slovaks resented Czech control. The *Sudeten Germans* (Germans who lived in the Sudeten Mountains of Czechoslovakia) also objected to Czech dominance.

German seizure. Adolf Hitler's rise to power in Germany during the 1930's increased the minority tensions in Czechoslovakia. Hitler encouraged the Sudeten Germans to demand self-rule. He threatened to declare war on Czechoslovakia if this demand was not met.

In 1938, representatives of France, Italy, and the United Kingdom signed an agreement with Hitler that forced Czechoslovakia to give the Sudeten territory to Germany (see *Munich Agreement*). Later that year, Hungary and Poland claimed parts of Czechoslovakia. In

1939, the Czechoslovak government surrendered to Hitler's demands for control over the rest of Czechoslovakia. German troops then occupied the country. Hitler made Bohemia and Moravia a German protectorate. Slovakia became a republic under German influence.

The German occupation brought widespread suffering during World War II (1939-1945). Uprisings against the Germans occurred in both Slovakia and the Protectorate of Bohemia and Moravia. More than 250,000 Czechoslovakians, including almost all the country's Jews, were killed during World War II.

Eduard Beneš, who had fled from Czechoslovakia in 1938, formed a government-in-exile in London during the war. He cooperated with both the Western powers and the Soviet Union (which had been formed under Russia's leadership in 1922 and existed until 1991). In 1943, he signed a treaty of friendship and cooperation with the Soviet government. By 1945, the Soviet Army had freed most of Czechoslovakia from the Germans. United States troops liberated parts of Bohemia. After World War II ended in 1945, the government-in-exile returned, and all foreign troops were withdrawn from Czechoslovakia. That same year, Czechoslovakia gave Ruthenia to the Soviet Union.

Communist rule. Beneš formed a coalition government to lead postwar Czechoslovakia. Communists held the most important positions in the new government, which had Soviet support. The government banned conservative political parties and took control of major industries. Hundreds of thousands of Germans and Hungarians living in Czechoslovakia were forced to leave.

In national elections held in 1946, the Communist Party received 38 per cent of the vote—more than any other party. The Communist Party chairman, Klement Gottwald, became prime minister of Czechoslovakia. But in local elections held in 1947, the Communists won a smaller percentage of the vote than they had won in 1946. At the same time, conflicts erupted between the Communists and the other parties in the government.

In February 1948, the Communists forced President

Important dates in Czechoslovakia

- c. A.D. 500 Ancestors of the Czechs and Slovaks settled in what was to become Czechoslovakia
- c. A.D. 900 The Magyars conquered Slovakia, and Bohemia became a powerful central European state.
- 1347 Charles of Bohemia became Holy Roman emperor, as Charles IV.
- 1419-1436 The Hussite Wars brought turmoil to Bohemia.
- 1526 Bohemia came under Habsburg rule.
- 1618 A Czech revolt touched off the Thirty Years War.
- 1918 The Czechs and Slovaks formed Czechoslovakia as an independent nation.
- 1938-1939 Germany seized control of Czechoslovakia.
- 1945 Czechoslovakia regained its independence.
- 1948 Communists took over the Czechoslovak government.
- 1968 Czechoslovakia's government began a programme of liberal reforms. Troops from the Soviet Union and other Communist nations invaded Czechoslovakia and ended the programme.
- 1989-1990 The Communist Party's control of the government ended, following widespread protests by the people. Free elections brought a non-Communist government to power.
- 1992 The Federated Czech and Slovak republics forming Czechoslovakia agreed to become two separate states.



Fertile farmland was one of Czechoslovakia's important natural resources. The country's best soil is along the river valleys of north-central Bohemia, central Moravia, and southern Slovakia. Under Communist rule, farmers, such as the women above, worked on large collective farms.

Beneš to form a government made up entirely of Communists and their supporters. Beneš resigned a few months later, and Gottwald succeeded him. The Communists then had complete control of the government.

The Communist take-over brought about revolutionary changes in Czechoslovakia. The government took over all businesses, industries, churches, and schools. Farmers were forced to join collective farms (also called cooperative farms) or state farms. The government-controlled farms occupied 90 per cent of Czechoslovakia's farmland.

The best farmland was along the river valleys of north-central Bohemia, central Moravia, and southern Slovakia. Farms in these areas produced barley, maize, rye, sugar beet, and wheat. In the highlands, farmers grew apples, cereal grains, flax, and potatoes. Hops grew in northwestern Bohemia. Many farmers raised beef and dairy cattle, pigs, poultry, and sheep. It was mostly mixed farming run on traditional lines.

On the collective farms, farmworkers jointly owned the farm equipment and property. They each received a share of the farm's profits and a small wage. The government owned and operated the state farms, and state farmworkers received salaries. The state farms were much larger than collective farms. Communist leaders believed that government-controlled farms would be more efficient than the peasants' small farms which they had replaced. But the huge farms were unpopular. The farmers received very low wages and were angered by the government's tight control over production. The working of the farms was inefficient and production fre-

quently fell below what the government demanded.

During the early 1950's, the Communist party staged a series of political trials. The secret police imprisoned many people who opposed the government. Many party officials were accused of treason and executed or imprisoned. Gottwald remained president of Czechoslovakia until 1953, when Antonín Zápotocký succeeded him. Antonín Novotný became president in 1957.

The 1960's. During the early 1960's, Czechoslovakia's agricultural and industrial production dropped, and there were shortages of food and other goods. Members of the Communist Party itself criticized the government's inability to reverse the economic decline. At the same time, the country's intellectuals called for more freedom of expression, and many Slovaks renewed their efforts to gain recognition for Slovak rights. In 1968, the Communists removed Antonín Novotný as party leader. Alexander Dubček, a Slovak, became the party leader, and Ludvík Svoboda became the country's president.

Dubček's government introduced a programme of liberal reforms. These included more freedom of the press and increased contacts with non-Communist nations. Dubček won popularity among Czechoslovakia's people for the reforms, known as the "Prague spring." But leaders of the Soviet Union and other Eastern European nations feared the programme would weaken Communist control in Czechoslovakia. As a result, in August 1968, troops from the Soviet Union, Bulgaria, East Germany, Hungary, and Poland invaded Czechoslovakia. The Soviet troops remained, but the other troops withdrew.



Protests against Communist rule broke out in Prague, above, and other parts of Czechoslovakia in 1989. They helped end Communism's leading role in government and society.

In 1969, the Czechoslovak Communist Party, under pressure from the Soviet Union, replaced Dubček with Gustáv Husák, another Slovak Communist. Thousands of people who had been active in the reform movement either resigned or were removed from the party. In 1975, President Svoboda left office because of poor health. Husák succeeded him and continued to serve as Communist Party leader as well. Under Husák, Czechoslovakia remained a tightly controlled Communist state and a loyal ally of the Soviet Union. The Husák government cancelled most of the Dubček reforms.

The Velvet Revolution. In 1987, Husák resigned as Czechoslovakia's Communist Party leader. He remained president. Miloš Jakeš succeeded Husák as party leader.

In November 1989, hundreds of thousands of people gathered in the streets of Prague to demand changes in the government and greater freedoms. The demonstrations were followed by general strikes and demonstrations by people across the country. In response to the widespread discontent, Communist Party General Secretary Jakeš resigned. Karel Urbánek replaced him.

In December 1989, the Communist-controlled Federal Assembly voted, under public pressure, to end Communism's leading role in the Czechoslovak government and society. Marián Čalfa, a liberal Communist, became prime minister and later left the Communist Party. President Husák swore in a new Cabinet consisting of a majority of non-Communist members. Non-Communist parties gained control of most key Cabinet ministries. Husák then resigned under pressure.

Husák was succeeded by Václav Havel, a non-Communist and a playwright. Havel was elected by the Federal Assembly. He became the country's most influential leader, a position traditionally held by the Communist Party head. Alexander Dubček, who had joined in the protests, returned to public life when he was appointed chairman of the Federal Assembly. The end of Communist rule was so smooth and peaceful that it became known as the *Velvet Revolution*.

The new government worked to increase free enterprise in Czechoslovakia. It restored such civil liberties as freedom of religion, speech, and the press. It also called

for free elections, which were held in June 1990. In the elections, the Civic Forum—the Czech party that had emerged in November 1989 to lead the Velvet Revolution—and its Slovak ally, Public Against Violence, won a majority of seats in the Federal Assembly. The Assembly reelected Havel president in July 1990. The Soviet Union withdrew its troops from Czechoslovakia in June 1991, six months before the Soviet Union broke up.

In 1992, Czechoslovakia's government took a large step toward establishing an economy based on free enterprise. It began to sell shares of stock in companies it had owned. As a result, more than 1,000 companies became privately owned. In addition, hundreds of thousands of new privately owned businesses were established.

However, the move toward a free-enterprise economy caused far more unemployment in Slovakia than in the Czech areas. Tensions between the Czechs and Slovaks prevented the adoption of a new constitution and slowed economic reform. Although many Czechs and Slovaks wanted to remain united, the prime ministers of the Czech Republic and Slovakia began negotiating the breakup of Czechoslovakia in June 1992. Havel resigned, saying he did not want to preside over the breakup of his country. On Jan. 1, 1993, the independent nations of the Czech Republic and Slovakia were created to replace Czechoslovakia.

Related articles. See *Czech Republic and Slovakia* and their lists of *Related articles*. See also:

Beneš, Eduard	Munich Agreement
Havel, Václav	Sudetenland
Heydrich, Reinhard	Warsaw Pact
Lidice	

Czechs are a Slavic people who make up most of the population of the Czech Republic. Most Czechs live in the regions of Bohemia and Moravia. They settled there during the A.D. 400's.

The Czechs, who are also called *Bohemians*, were among the first Slavic groups to create their own state. The state became part of the Holy Roman Empire in the 900's. The Czechs lost their independence to Austria in 1620 but maintained their culture. They were admired for their achievements in art, literature, and music. The Czechs regained political independence in 1918. They and the Slovaks formed the republic of Czechoslovakia. In 1992, Czechoslovakia ceased to exist and the two countries of the Czech Republic and Slovakia were created.

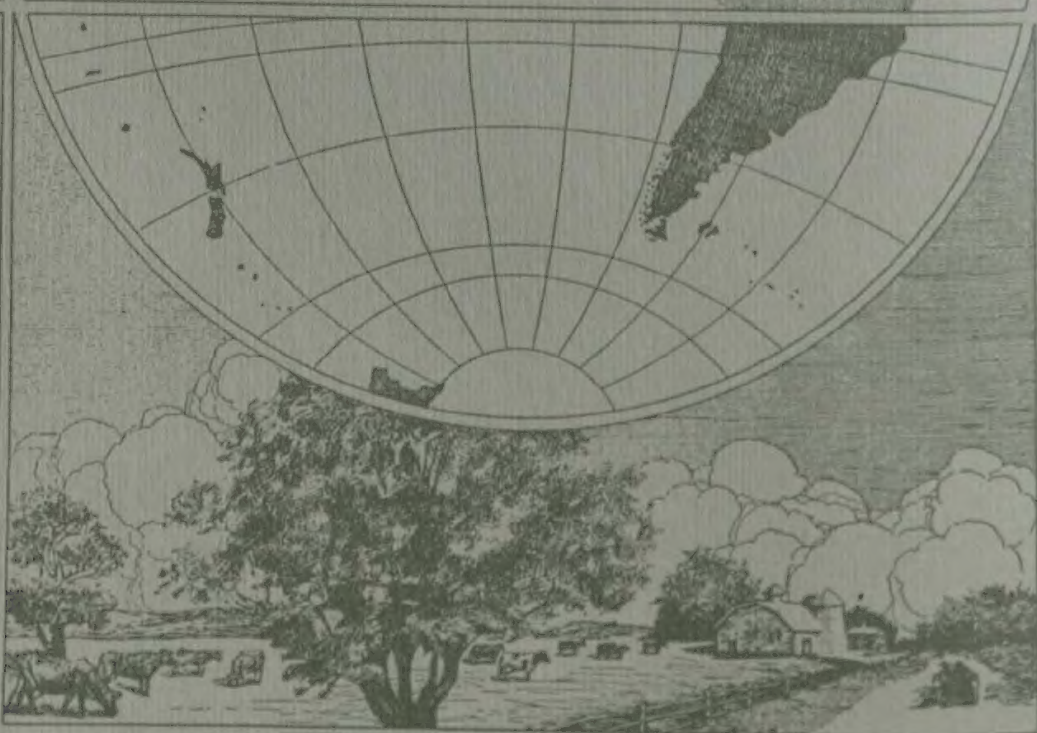
See also *Czech Republic (People)*.

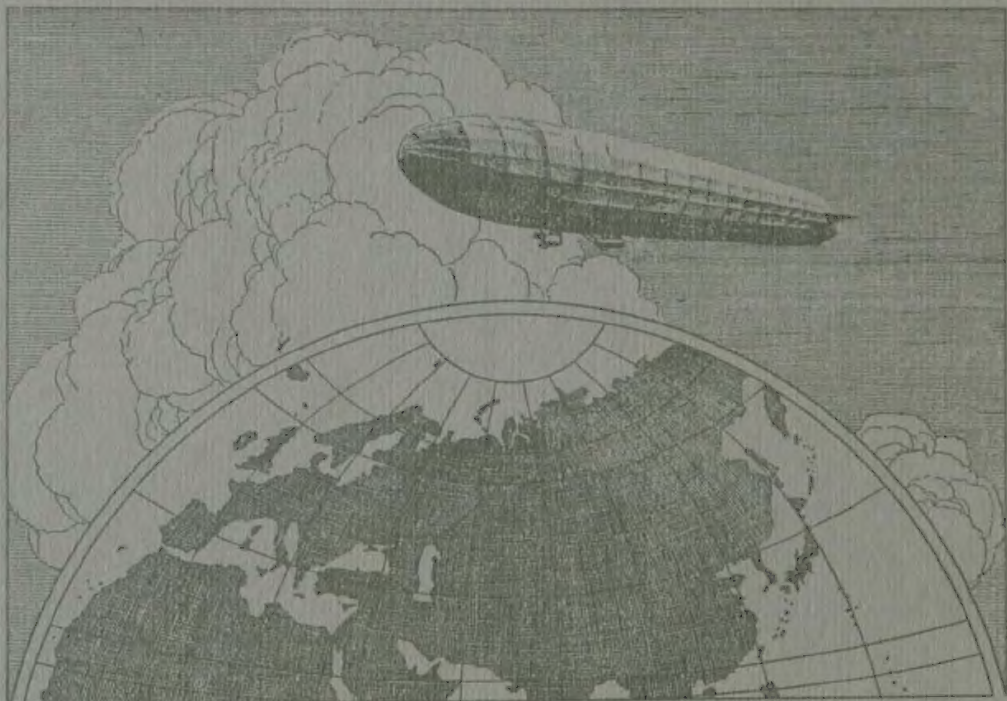
Czerny, Karl (1791-1857), was an Austrian composer, teacher, and pianist. Czerny composed more than 1,000 works in almost every vocal and instrumental form. He also arranged many works by other composers for piano. But his reputation rests largely on his many instructional compositions for piano. These compositions are called *études*.

Czerny was born in Vienna. He was a friend of the German composer Ludwig van Beethoven and studied with him from 1800 to 1803. Early in his career, Czerny gave frequent piano recitals. But he gradually gave up public performing and concentrated on teaching and composing. Czerny became a successful teacher by the age of 15. His pupils included the famous Hungarian pianist and composer Franz Liszt.



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